

# **SPECIAL PROVISIONS**

## SECTION 00910

### SPECIAL PROVISIONS

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### **SP-01 INCORPORATION OF THE MPWSS**

All provisions of the Montana Public Works Standard Specifications, Sixth Edition, April 2010, hereafter collectively referred to as the MPWSS, apply to the project, except where portions of the MPWSS are modified or replaced by the Contract Documents. Each Section of the MPWSS that has been modified is listed in the Table of Contents of Section 00950 Standard Modifications to MPWSS. The entire Section from the MPWS has not been rewritten for these modifications. Instead, modifications are indicated for a specific subsection, paragraph, sentence or drawing.

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**Delete Part 4: MEASUREMENT AND PAYMENT in all sections of the MPWSS.** Payment for an item will only be made if that item is listed as a Bid Item in Section 00300: Bid Form. If an item is listed as a Bid Item, administrative and procedural requirements will be listed in Section 01275: Measurement and Payment. If an item is not listed as a Bid Item, the item is not required or is considered an incidental cost to other Bid Items.

### **SP-02 SUBSURFACE AND PHYSICAL CONDITIONS**

In the preparation of Drawings and Specifications, the Engineer or Engineer's Consultants relied upon the following reports of exploration and tests of subsurface conditions at the Site:

1. *Test Pit Logs*

These reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which the Contractor may rely as identified and the above are incorporated therein by reference. Contractor is not entitled to rely upon other information and data utilized by Engineer and Engineer's Consultants in the preparation of Drawings and Specifications.

### **SP-03 PREBID EXPLORATION/SITE INFORMATION**

All Bidders are strongly encouraged to visit the site of the work and conduct all field investigations at their disposal to become acquainted with the nature of the work. Obtain written authorization from the Owner, utilities, and others who may be directly affected prior to entering the property, conducting field tests, drilling, boring, excavating, or test pumping.

If potential Bidders wish to excavate test pits, the excavations will be limited to the vicinity of those areas that appear on the Drawings to be excavated. Excavations in paved areas will not be allowed without

written permission from the Owner. Excavations must be backfilled in a reasonably uniform manner and graded to the original ground surface line and grade. Backfill in unpaved streets, parking areas, or alleys must be compacted as specified in the Contract Documents and surfaced with four inches of new or existing gravel.

#### **SP-04 SPOIL**

In areas where confines limit the placement of spoil, the Contractor may have to haul the spoil out of the area until he is ready to backfill. The locations of spoil placement will be discussed at the preconstruction conference and will be subject to approval by the Engineer and Owner. The Contractor will be responsible for the disposal of all excess spoil.

No additional payment will be allowed the Contractor for this work. Refer to Section 01275: Measurement and Payment for more information.

#### **SP-05 BEST MANAGEMENT PRACTICES**

**Dust Control** – Dust control is to be considered an integral part of the Work. Dust Control shall be provided from the start of construction until the Work is complete. Fugitive dust as a result of construction shall be controlled at all times within the subject property. The Contractor shall have a water truck available for dust control prior to beginning any construction tasks. Wetting shall be done a minimum of twice per day in dry conditions or at the direction of the Engineer or Owner as required until the final construction activities are completed. Contractor shall be prepared to provide dust control until the final surface restoration is completed. All costs incurred to meet dust control requirements are incidental to other items of the contract and no separate payment shall be made.

**Road and Parking Lot Cleaning** – It shall be the sole responsibility of the Contractor to keep all roads and parking lots free from mud, gravel, cobbles or other contaminants generated as a result of construction activities. It shall be the responsibility of the Contractor to clean all foreign matter from roads and parking areas in a reasonable amount of time as determined by the Owner & Engineer. All costs incurred to meet road and parking lot cleaning requirements are incidental to other items of the contract and no separate payment shall be made.

**Erosion Control Measures** – Temporary erosion and sediment control measures includes the installation and maintenance of temporary structural control measures to reduce or eliminate the erosion of soil and transport of sediment offsite as result of construction activities. This may include, but not be limited to, silt fences, ditch checks, sediment basins, erosion control mats, stabilized construction entrance, temporary diversions, inlet protection, sediment traps, and slope drains. If erosion control measures are required, it shall be the responsibility of the contractor to install and maintain them throughout the construction. All costs incurred to meet erosion control requirements are incidental to other items of the contract and no separate payment shall be made.

**Noxious Weed Control** – Comply with the County Noxious Weed Management Act, Title 7, Chapter 22, Part 21 and all county and contract noxious weed control requirements. Determine the specific noxious weed control requirements of each county where the project is located before submitting a bid. Equipment and vehicles will be washed prior to entering the project site to remove vegetation to avoid the spread of weeds. All costs incurred to meet noxious weed control requirements are incidental to other items of the contract and no separate payment shall be made.

**Failure to Provide Service** – If the contractor fails to provide adequate service on the above listed items, the Owner reserves the right to contract these activities to a third party, the cost of which will be deducted from the contract amount at the time of the next pay request.

#### **SP-06 WATER FOR CONSTRUCTION**

The Contractor is responsible to obtain water for construction.

#### **SP-07 PARK ACCESS**

At all times during construction, afford Montana FWP and visitors access to the Upper Park Visitor Center and picnic areas to the highest degree possible. If construction takes place during the month of December, provide access for visitors to the Park Candle Light Tours.

#### **SP-08 REMOVAL AND REPLACEMENT OF FENCES, SIGNS, BARRICADES, ETC.**

Culverts, fences, signs, posts, barricades, etc. may be encountered during construction that may hinder construction operations. Remove and replace these objects as necessary to conduct construction operations. Replace objects removed in as good or better condition as previously existed and to the satisfaction of the Engineer.

No additional payment will be allowed the Contractor for this work. See Section 01275: Measurement and Payment and the Drawings for more information.

#### **SP-09 STAGING AREA**

A construction staging area will be provided by The Owner. The location of the staging area will be coordinated with the Owner and will be discussed at the pre-bid meeting. Take care to protect, preserve and/or replace objects and structures encountered within the confines of the staging areas and restore all disturbed areas as close as possible to original condition as possible unless otherwise dictated in these specifications.

Storage of construction materials, equipment, and other items pertinent to the construction of the project will be allowed in the staging areas. However, bulk storage of petroleum based products stored in tanks will not be allowed. At all times, spill kits must be available on-site for any accidental spills of petroleum.

No payment will be allowed to the Contractor for any work, including restoration, with regards to the staging areas.

#### **SP-10 CONFLICTS WITH UTILITIES**

Utility locations are based on the best available information which has been provided to or discovered by the Engineer. There is no guarantee as to the accuracy and completeness of this information.

The Contractor shall coordinate his work with all utility companies or private entities that may be affected by the project. The Contractor will also coordinate with the appropriate utility owners to relocate, remove, replace, cross, work around, support, or other as necessary to conduct construction operations. The Contractor will pay for any charges associated to relocate, remove, replace, cross, work around, support, or other as necessary to conduct construction operations and properly construct the project. The Contractor shall be solely responsible for any damage to these utilities due to his operations. The

Contractor shall work closely with the utilities to ensure their criteria are met and no problems result. No separate payment will be made for this work and the Contractor shall figure the cost of such work into other applicable bid items. The Contractor shall also check with the Utilities Underground Location Center (1-800-424-5555) at least 48 hours in advance so that all utilities are located prior to digging.

#### **SP-11 DEWATERING**

The Contractor will be responsible for any dewatering operations which may be necessary to adequately remove water such that construction activities can be completed as specified. The Contractor will be responsible for conveyance and disposal of water to surface watercourses. Make all necessary arrangements for infringements across private property and obtain and adhere to any necessary discharge permits from the Montana DEQ.

#### **SP-12 TESTING**

Complete testing of all components of the project will be required to the satisfaction of the Owner and the Engineer. The Contractor (at no additional expense to the Owner) shall remedy all defects and performance problems revealed by the testing to the satisfaction of the Engineer and the Owner.

The Engineer will conduct the following tests at no cost to the Contractor:

1. On-site moisture and density testing of trench backfill, embankments, engineered fill placement, crushed base course, and asphalt pavement.

Should the materials fail to meet the test specified, the Contractor will pay the costs of all retests conducted by the Engineer, or the Contractor may elect to have an approved testing laboratory conduct retests at the Contractor's expense.

The Contractor will be responsible for conducting and paying for the following tests and any other tests as indicated on the drawings or within this Project Manual:

1. Laboratory analysis of concrete aggregate.
2. Slump and Air Entrainment tests for concrete.
3. Taking and breaking of concrete test cylinders.
4. Gradations for gravels, bedding, and base materials as specified.
5. Proctors for different materials and gravels used for backfill.
6. Pressure testing of water mains
7. Tests of all pumps, and U.V. System.
8. Other tests as outlined in the Technical Specifications.

All tests which are the responsibility of the Contractor must be conducted by an approved, certified testing laboratory or individual. Acceptance or rejection of materials will generally be determined from tests made in-place in the field.

The following is frequency testing table for soils and concrete:

**Quality Control Frequency Table**

SECTION	ITEM DESCRIPTION	TEST OR SUBMITTAL	FREQUENCY
<b>GENERAL</b>			
Varies	All Materials	Sieve Analysis	Every New Material
Varies	All Materials	Atterberg Limits	Every New Material
Varies	All Materials	Lab. Max Density	Every New Material
02221	Type 1 Pipe Bedding	Field Density/Moisture Content	1 test / 200 LF
02221	Pipe Bedding Alternate	Field Density/Moisture Content	1 test / 200 LF
02221	Type 2 Pipe Bedding	Field Density/Moisture Content	1 test / 200 LF
02221	Type 'A' Trench Backfill	Field Density/Moisture Content	1 test / 200 LF / lift
02221	Type 'B' Trench Backfill	Field Density/Moisture Content	1 test / 300 LF / lift
02221	Type 'C' Trench Backfill	Field Density/Moisture Content	1 test / 400 LF / lift
02300	Select Fill/Structural Fill	Field Density/Moisture Content	1 test / 1,000 SF / lift
<b>GENERAL – ROADWAY</b>			
Varies	All Materials	Sieve Analysis	Every New Material
Varies	All Materials	Atterberg Limits	Every New Material
Varies	All Materials	Lab. Max Density	Every New Material
02230	Borrow / Embankment Fill	Field Density/Moisture Content	1 test / 5,000 SF / lift
02230	Original Ground / Native Subgrade	Field Density/Moisture Content	1 test / 5,000 SF / lift
02235	Base Course(s)	Field Density	1 test / 2,000 SF / lift
02235	Base Course(s)	R-Value	Every New Material
02235	Base Course(s)	Fractured Face	Every New Material
02235	Base Course(s)	Sand Equivalent	Every New Material
02235	Base Course(s)	% of Wear (500 rev.)	Every New Material

<b>STRUCTURES</b>			
Varies	All Materials	Sieve Analysis	Every New Material
Varies	All Materials	Atterberg Limits	Every New Material
Varies	All Materials	Lab. Max Density	Every New Material
03310	Structural Concrete	Mill Certificates	With Every Mix Design
		Mix Design	Every Concrete Class
		Air Content	1 test / 75CY / Day
		Slump	1 test / 75CY / Day
		Compressive Strength	1 test / 75CY / Day
		Temperature	1 test / 75CY / Day
	Original Ground and Base of Cuts (Native Subgrade)	Field Density/Moisture Content	1 test / 1,500 SF

### **SP-13 CONSTRUCTION STAKING**

The Engineer will provide horizontal control for the project consisting of stakes along the project baseline. Vertical control will be provided by benchmarks throughout the project site. All offset staking is the Contractors responsibility. The Contractor shall protect all control points during the course of their work and replace any points damaged or removed by their activities. All survey monuments and stakes provided by the Contractor shall be subject to inspection and verification by the Engineer. The Contractor shall provide all additional staking necessary for vertical and horizontal control such that the project may be completed in accordance with the plans and specifications.

The Engineer shall provide the following staking consisting of stakes or hubs.

- Vertical Control – Vertical control will be provided by benchmarks throughout the project site.
- Piping – Horizontal control will be given at each change in horizontal alignment, pipe termination, structure, valve and each fitting. Intermediate staking will be placed on centerline a minimum of every 200 feet.
- Structures– Horizontal control will be given at the centerline of each new structure.
- Gates – Horizontal control will consist of stakes at gate post centers.
- Roadway – Horizontal control will consist of a minimum of each PC and PT along the centerline of the new road. Intermediate staking on centerline will be placed a minimum of every 50 feet.

Actual new main locations may vary from either side of the centerline of pipe as shown on the Drawings if it is required to avoid utilities, obstructions, pavement, etc. Since this will be to the benefit of the Contractor, no additional cost will be allowed the Contractor. The Engineer will determine the actual locations of the new mains in the field.

### **SP-14 WINTER SHUTDOWN**

A shutdown due to inclement weather during the winter months may be requested by the Contractor. Indicate the number of calendar days being requested in the original shutdown request. This initial request may be extended during the shutdown period as long as such extension is justifiable and requested



at least 14 days prior to the date the original extension was to elapse. Any extension of shutdown will require the Contractor to demonstrate that adequate operations can be maintained throughout the extended period. Shutdown extensions may require operation modifications and approval of the Montana DEQ. Only one winter shutdown will be granted during the project.

The Owner reserves the right to approve or disapprove any shutdown or extension requests. As a condition of approval of a shutdown, close all open excavations, provide for maintaining traffic, and provide for protection of public property at the work site. The Contractor will not be allowed to perform any work during the shutdown period unless prior approval is granted by the Owner.

#### **SP-15 PERMITS**

The Owner and Engineer will obtain the following permits at no expense to the Contractor. The Contractor will be required to carry out all provisions of these permits as part of this contract.

1. Montana Department of Fish, Wildlife, and Parks – Montana Stream Protection Act (SPA124 Permit). This permit requires the Contractor to minimize the impact on fish, wildlife and riparian areas through proper construction practices and erosion control measures. The Contractor shall adhere to all requirements set forth in the permits obtained by the Owner.
2. Montana Department of Environmental Quality – Short-Term Water Quality Standard for Turbidity (318 Authorization).
3. U.S. Army Corps of Engineers – Federal Clean Water Act (404 Permit).

The Contractor is responsible for obtaining all other necessary permits, licenses, agreements, insurance, and approvals required by any government authority or agency for the performance of this work at his own expense. Owner will allow Contractor access, as appropriate and necessary, for obtaining data in regard to permits and, at its own discretion, may assist Contractor, when necessary, in obtaining such permits. These Permits may include but are not limited to the following:

1. Building Permit
2. Storm Water Pollution and Prevention Plan (SWPPP)
3. Electrical Permit.

#### **SP-16 WORKING HOURS**

Regular working hours are defined as an eight-hour period (plus 1 hour lunch allotment) within the bounds of 7:00 AM and 7:00 PM. Work during other hours may be permitted following written approval of the Owner. Contractor shall provide the Engineer a request at least three (3) days prior to working other hours, or in excess of 8 hours per day. Engineer shall provide a response to the request within 24 hours of receipt. Emergency work may be done without prior permission.

#### **SP-17 UNSCHEDULED EMPLOYMENT OF THE ENGINEER**

Damages for the unscheduled employment of the Engineer and/or Inspector will be assessed against the Contractor necessitated by: (1) the Contractor working beyond the specified contract time; (2) the Contractor working more than 8 hours per day, (or 40 hours per week if four ten hour shifts are run) or on

Saturdays, Sundays, and Federal Holidays; (3) the Contractor utilizing material, supplies, or equipment that requires the redesign of the project; (4) the Contractor destroying or disturbing baselines, benchmarks, or reference stakes; (5) the failure of the Contractor to maintain acceptable as-built records, and (6) review of submittals that were returned to the Contractor requiring revision or resubmittal; (7) Review of Substitutions to the proposed design.

Damages for the unscheduled employment of the Engineer and/or Inspector will be determined based on the following hourly rates:

<b>Straight Time</b>	
Senior Project Manager	\$145.00/Hour
Project Manager	\$135.00/Hour
Project Engineer	\$90.00/Hour
Resident Project Representative (RPR)	\$90.00/Hour
RPR Overtime Rate	\$135.00/Hour
Clerical	\$55.00/Hour
Mileage	\$ 0.75/Mile
Survey Crew	\$160.00/Hour
GPS Rental	\$400.00/Day
Nuclear Densometer	\$75.00/Day

The rates listed herein are subject to changes on January 1<sup>st</sup> of each year.

Out of pocket expenses for materials, equipment, supplies, transportation, and subsistence will be billed at cost plus ten percent. Damages for unscheduled employment of the Engineer and/or Inspector will be deducted from monthly progress payments and the final payment as the damages are incurred. Damages for unscheduled employment of the Engineer are independent from liquidated damages for delay as described in the agreement.

#### **SP-18 CONTRACTOR EMERGENCY CONTACT**

Provide a primary and secondary 24-hour, 7-day a week emergency contact.

#### **SP-19 NOXIOUS WEEDS**

Comply with the County Noxious Weed Management Act, Title 7, Chapter 22, Part 21 and all county and contract noxious weed control requirements. Determine the specific noxious weed control requirements of each county where the project is located before submitting a bid. Equipment and vehicles will be washed prior to entering the project site to remove vegetation to avoid the spread of weeds. All costs incurred to meet noxious weed control requirements are incidental to other items of the contract.

#### **SP-20 SEEDING**

Furnish a native seed mixture, to be placed all disturbed areas, containing slender wheatgrass (15%), western wheatgrass (20%), thickspike wheatgrass (20%), mountain brome (13%), green needlegrass

(25%), snake river wheatgrass (5%), blue flax (2%). Alternate mixes may be used, with Engineer's approval. **Place seeding on all disturbed areas.**

Sow seed in the areas described in the Contract Documents at the rate of 12 to 15 pounds per acre (13.4 to 16.8 kg/ha) on a "pure live seed" basis.

The necessary bulk seed can be calculated by:

$$\text{Necessary Bulk Seed} = \frac{\text{Total Pounds (kg) Pure Live Seed Required}}{(\% \text{ Germination}) \times (\% \text{ Purity})}$$

### **SP-21 TRACER WIRE**

Jacketed #14 copper wire shall be used for detection wire with HDPE and PVC pipe. Jacketed #14 copper detection wire shall be installed on all water mains and sewer force mains. All spliced and repaired wire connections in the tracer wire system shall be made using solderless splice kits. No splices will be allowed for wire lengths less than 500 feet. All tracer wire shall be tested by the Contractor prior to final inspection. Contractor shall notify the Engineer 24 hours in advance of the testing.

No separate payment will be made for this work. The cost of furnishing and installing the tracer wire system shall be incidental to other appropriate bid items. See Section 01275: Measurement and Payment and the Drawings for more information.

### **SP-22 CLEAN AND DISINFECT EXISTING SPRING BOX AND INLET PIPE**

The existing concrete spring box, located approximately 1,600 feet upstream of the pump/treatment building, will continue to be used and operated by FWP. The volume of the existing spring box is approximately 2,800 gallons. The Contractor is responsible for properly cleaning and disinfecting the existing spring box and inlet 3" pipe as part of the contract. The cistern shall be disinfected per the requirements of AWWA 652 – *Disinfection of Water Storage Facilities*.

The inflow to the cistern shall be temporarily plugged and/or the upstream valve fully closed. All tools, rags and other materials not a part of the structural or operating facilities of the cistern shall be removed. Then the surfaces of the walls and floor shall be cleaned using high pressure water jet, sweeping, scrubbing or equally effective means. All water, dirt, and foreign material accumulated in this cleaning operation shall be discharged or otherwise removed.

The primary areas of bacteriological growth concern are along the bottom 6" of the cistern floor. A water and chlorine solution shall be added to the cistern in amounts such that the solution will initially contain 50 mg/L available chlorine and will fill approximately 5 percent of the total storage volume. This solution shall be held in the storage facility for a period of not less than 6 hours. The cistern shall then be filled to the top introducing non-chlorinated water into the highly chlorinated water and be held for a period not less than 24 hours. Following this, all highly chlorinated water shall be safely purged from the piping and cistern.

The contractor shall also disinfect the inlet 3" pipe by injecting approximately 6-10 gallons of 50ppm chlorine solution into the 3" pipe as needed to fill the pipe between the gate valve and existing infiltration gallery. The chlorine solution shall be introduced from the cistern and pumped toward the infiltration gallery and allowed to be retained for a minimum 6 hour period.

The chlorinated water used in disinfection shall be properly disposed of and/or neutralized prior to discharge. The Contractor shall submit the cleaning and disinfection plan to the engineer for approval prior to starting work.

### **SP-23 GALVANIZED TRANSMISSION PIPELINE**

This special provision applies to the proposed replacement of the 1.5-inch galvanized transmission pipeline from the pump house to the storage tank. The work, which is bid as an additive alternative to the base bid, is only to be constructed as needed if FWP chooses.

The galvanized pipeline alignment shall follow the existing transmission line alignment. The Contractor shall install the pipe without sags over low areas. Where sags cannot be overcome by pipe realignment, the Contractor shall construct pipe supports to eliminate low areas. Shop Drawings of these pipe supports shall be submitted to the Engineer for approval prior to construction.

### **SP-24 PREFABRICATED PACKAGED SYSTEMS**

The use of pre-engineered and prefabricated packaged systems proposed as a substitution for portions of the pumping and treatment system or the entire pumping/treatment building will be considered. Any possible substitutions will be reviewed during the post-bid submittal process, and not prior to bid. See SP-17 for redesign and resubmittal review. The materials and equipment comprising any proposed package system(s) shall meet the requirements of the plans and project specifications and shall be of equivalent or superior quality than the proposed material and equipment. The Engineer shall make the final determination if the proposed substituted product are "equal or superior quality". Any proposed package system substitutions that include cartridge filters or UV disinfection equipment must be as shown on the plans and specifications. Packaged systems that include the building shall also meet the type and aesthetics of the proposed building (ie. insulated precast concrete utility building with "barn wood" texture exterior.) If a substituted building is proposed, both the Engineer and the Owner must approve all substituted products. Slight variations in building sizes larger than the proposed building would be considered.

The Engineer and FWP reserves the right to reject any or all proposed packaged system substitutions.

**END OF SECTION**

# **STANDARD MODIFICATIONS TO MPWSS**

## SECTION 00950

### STANDARD MODIFICATIONS to MPWSS (6<sup>th</sup> EDITION)

SM-00001	GENERAL .....	2
SM-01050	FIELD ENGINEERING .....	2
SM-01300	SUBMITTALS .....	2
SM-02221	TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES .....	2
SM-02235	CRUSHED BASE COURSE .....	8
SM-02660	WATER DISTRIBUTION .....	8
SM-02725	DRAINAGE CULVERTS .....	12
SM-03210	REINFORCING STEEL .....	13
SM-03310	STRUCTURAL CONCRETE .....	13

## **SM-00001      GENERAL**

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## **SM-01050      FIELD ENGINEERING**

Delete Section 01050 in its entirety.

## **SM-01300      SUBMITTALS**

Delete Section 01300 in its entirety and replace with Section 01300: SUBMITTALS contained in the Project Manual.

## **SM-02221      TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES**

Add the following publications to the list in Section 02221.1.2.A.

ASTM D4235	Relative Density
ASTM D4254	Relative Density

Delete Section 02221.1.4.A.1 replace with the following.

1. Meet the testing requirements of Special Provisions.

Delete Section 02221.1.4.A.3 and replace with the following.

3. Re-testing failing areas is at the expense of the Contractor. Where Engineer provides testing on behalf of the Owner, the Contractor will be assessed the cost of all retests conducted by the Engineer, with that cost deducted from the progress payments.

Delete Section 02221.1.4.B.1 and replace with the following.

1. Quality assurance tests will be made by the Contractor for each on-site natural soil or each source of off-site material, including borrow material, to determine the laboratory maximum density values and optimum compaction moisture content according to ASTM D698.

Delete Section 02221.1.4.C.2 and replace with the following.

2. Submit to the Engineer laboratory moisture-density relationship testing results of on-site and off-site borrow soils.

Delete Section 02221.2.1.A and replace with the following.

A. TYPE 1 PIPE BEDDING

1. Type 1 Pipe Bedding includes the material placed from 4 inches (10 cm) below the bottom of the pipe to 6 inches (15 cm) over the pipe.
2. Provide Type 1 Bedding consisting of crushed stone or gravel, which is free of cementitious substances or thin, flat particles in an amount that would cause the material to cake, pack, or otherwise form an unyielding support for the pipe.
3. Provide imported granular material with a gradation as follows and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.

Percent by Weight Passing	
Sieve Size	% Passing
1" (25 mm)	100
3/4" (19.0 mm)	90 - 100
3/8" (9.5 mm)	20 - 55
No. 4 (4.75 mm)	5 - 10
No. 8 (2.36 mm)	0 - 5

4. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 50 percent of the material retained on the No. 4 sieve has at least one fractured face.



5. To prevent migration of material from around the pipe, do not use sand, sandy gravel, or a material composed mainly of sand for bedding material in the pipe zone where ground water is or will be present or where existing material contains voids which would allow migration. Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be well graded, free draining, and non-plastic.
6. Refer to the Special Provisions and details in the Drawings for other requirements.

Delete Section 02221.2.1.B in its entirety.

Delete Section 02221.2.1.C.3 and replace with the following.

3. Type 2 Bedding consists of granular material meeting the following gradation and having a maximum plasticity index of 6 and a maximum liquid limit of 25 percent.

Percent by Weight Passing	
Sieve Size	Type B-Modified
3" (75 mm)	100
No. 4 (4.75 mm)	0 - 25
No. 8 (2.36 mm)	0 - 10

Delete Section 02221.3.3.A.8 and replace with the following.

8. No classification of trench excavated material materials will be made. Excavation and trenching work includes the removal and subsequent handling of all earth, loose or cemented gravel, loose or solid rock, and other materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof. All materials excavated or otherwise removed including asphalt, curb, gutter, sidewalk, soils, etc., will become the property of the Contractor, who will be responsible for environmentally sound disposal of said material in accordance with state and federal regulations.

Add Section 02221.3.3.B.2.b.

- b. If the trench is excavated wider than the specified minimum, provide Type 1 Pipe Bedding for the additional width to yield a consistent backfill for the entire width of the trench or take such other measures as the Engineer may direct to protect the pipe against the crushing forces of trench backfill at the Contractor's expense.

Delete Section 02221.3.4.A and replace with the following.

A. General

1. Furnish all necessary labor, equipment, and incidentals necessary to dewater the project site during construction.
2. Keep all excavation dry and free from water during construction and the placement of materials. Do not place pipe, bedding, or backfill materials below the groundwater elevation established by dewatering operations. Do not allow ground water or storm water to enter or flow through the underground piping during installation.
3. The cost of dewatering operations will be incidental to the cost of pipeline and appurtenance installation and no additional payment will be made for dewatering. Consider shifts in the groundwater level caused by changing seasons or local conditions in estimating the cost of dewatering operations, as no additional payments will be made for fluctuating groundwater levels.
4. Protect all structures that could be potentially impacted by dewatering operations. Repair any damage to structures caused as a result of dewatering at Contractor's expense.

Add Section 02221.3.4.B.

B. Discharge

1. Do not discharge or dispose of water from dewatering operations in such a manner as to flood existing landscaped areas, graveled areas, or structures unless approved by Engineer. Written permission from the appropriate landowner shall also be required for discharge or disposal on private property.
2. It is the Contractor's responsibility to comply with requirements and regulations of federal, state, and local agencies that govern areas affected by dewatering of the construction site and application for, and maintenance of, any required permits.

Add Section 02221.3.6.A.2.

2. Storage of all imported backfill materials, including protecting said materials from adverse conditions that would disqualify them from use under these specifications, is the responsibility of the Contractor.

Delete Sections 02221.3.6.B.1.a and b and replace with the following.

- a. Place Type 1 Pipe Bedding material 4 inches (10 cm) under, around the pipe, and to a point 6 inches (15 cm) above the top of the pipe in 6 inch (15 cm) lifts, using hand or other compaction methods without damaging or disturbing the pipe including mains and service lines and all appurtenances.
- b. Place bedding material in equal lifts on both sides of the pipe for the full trench width. Thoroughly compact each lift of pipe bedding by tamping, vibration, slicing with a shovel, rodding, or by a combination of these

methods. Take special care to assure complete compaction under the haunches of the pipe.

Delete Section 02221.3.6.B.2 in its entirety.

Delete Section 02221.3.6.C.1 and replace with the following.

1. After the pipe bedding materials are placed and compacted as specified, backfill the trench.
  - a. Use backfill material free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious material.
  - b. From the top of the Type 1 Bedding to 6 inches (15 cm) below the ground surface, or the subgrade elevation, material containing stone up to 8 inches (20 cm) in the greatest dimension may be used.
  - c. Cost of screening, drying, or moistening excavated backfill to comply with specifications will be considered incidental to the Contractor's bid price per linear foot of pipe and service lines, and unit prices for appurtenances, and no additional payment will be made for such work.

Delete Sections 02221.3.6.C.6.a through c and replace with the following.

- a. Type A Trench Backfill. Place trench backfill in maximum 8 inch (20 cm) compacted lifts within 3 percent of optimum moisture content and compact to at least 95 percent of maximum dry density determined by AASHTO T99 or by ASTM D698. For materials that do not exhibit a typical well-defined moisture-density curve, compact backfill to 70 percent relative density as determined by ASTM D4253 and D4254.
- b. Type B Trench Backfill. Place trench backfill in maximum 8 inch (20 cm) compacted lifts within 3 percent of optimum moisture content, and compact to at least 90 percent of maximum dry density determined by AASHTO T99 or by ASTM D698. For materials that do not exhibit a typical well-defined moisture-density curve, compact backfill to 50 percent relative density as determined by ASTM D4253 and D4254.
- c. Type C Trench Backfill. Place and compact Type C Trench Backfill in maximum 12 inch (30 cm) lifts at densities equal to or greater than the densities of adjoining undisturbed soil. Mound earth over the trench top, if so directed by the Engineer. In cultivated areas, place stripped topsoil uniformly over the backfilled trench to the original depth. Do not compact the topsoil, but grade to provide a smooth surface conforming to the adjoining ground surfaces.

Delete Section 02221.3.6.D and replace with the following.

- D. Replacement of Unsuitable Backfill Material

1. Remove and dispose of excavated soils that are saturated, contain deleterious materials, or have characteristics that, in the opinion of the Engineer, render the soils unsuitable as backfill, and/or which cannot be readily conditioned or dried to be made suitable.
2. Replace unsuitable soils with material obtained from trench excavations within the project limits at the expense of the Contractor.
3. If suitable replacement material is not available within project limits, notify the Engineer. The Engineer will quantify the extent of any unsuitable soils to be removed and replaced with material from an approved source, to be paid for as Imported Backfill Material, and provide written notification of the approved quantities to the Contractor. Payment for Imported Backfill Material will not be approved if Contractor fails to notify the Engineer and/or proceeds with removal and disposal of unsuitable material prior to receiving written notice from the engineer.
4. Provide imported backfill material with a gradation as follows and a maximum plasticity index of 10, determined by AASHTO T89 and T90 or by ASTM D4318. Imported backfill may not contain rock measuring greater than 6 inches (15 cm) in the greatest dimension.

Percent by Weight Passing	
Sieve Size	% Passing
1" (25 mm)	70 -100
No. 4 (4.75 mm)	40 - 80
No. 10 (2.00 mm)	25 - 60
No. 200 (0.075 mm)	2 - 35

5. Place and compact all imported material according to the applicable backfill specification requirements.

Delete Section 02221.3.6.F.1 and replace with the following.

1. Provide warning tape as described in this Section. Bury tape a maximum of 18 inches (45 cm) below finish surface grade.

Add Section 02221.3.8.B.

- B. Dispose of vegetation; coarse debris resulting from pavement or sidewalk removal; stones, junk, debris, and other materials encountered in excavation work; and other similar waste materials away from the site of the work at the Contractor's expense.

Delete Section 02221.3.9.C and replace with the following.

- C. The maximum permissible distance between backfilling/compaction operations and the end of newly installed pipe is 100 feet (30 m) in existing streets (and/or alleys) and 200 feet (60 m) in all other areas.

Delete Section 02221.3.9.E. and replace with the following.

- E. For each work group consisting of a trench excavator, a pipe laying crew, and a backfilling/compaction crew, the maximum allowable open ditch at any time is 200 feet (60 m) in existing streets (and/or alleys) and 400 feet (120 m) in all other areas.

Add Section 02221.3.9.G.

- G. At the completion of each working day, fill all trenches and/or provide safety netting, Jersey barrier, and other barricades required for public safety.

Add Section 02221.3.10.

### 3.10 DRAINAGE CROSSINGS

- A. Where trenches are constructed in or across roadway ditches or other water courses, protect the backfill from surface erosion by adequate means. Where the grade of the ditch exceeds 1 percent, prevent erosion by a suitable method approved by the Engineer. Backfill trenches in such a manner that water will not accumulate in unfilled or partially filled trenches.
- B. Remove all material deposited in roadway ditches or other water courses crossed by the trench immediately after backfilling is completed and restore the section, grades, and contours of such ditches or water courses to their original conditions, in order that the surface drainage is obstructed no longer than necessary.

## **SM-02235 CRUSHED BASE COURSE**

Delete Section 02235.2.2.C and replace with the following:

- C. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 50 percent of the material retained on the No. 4 sieve has at least one fractured face.

Delete Section 02235.2.4.A and replace with the following.

- A. Use water from an approved source.

## **SM-02660 WATER DISTRIBUTION**

Add the following publications to the list in Section 02660.1.3.

ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Services
AWWA C600	Installation of Ductile-Iron Water Main and Their Appurtenances

Add Section 02660.2.2.B.5.b.

- b. Restrained joint systems and mechanical restrained joint fittings shall be installed where specifically indicated in the Drawings. Restrained joints may also be allowed in applications not specifically identified in the Drawings in lieu of concrete thrust blocks with Engineer approval.
  - 1) Furnish restrained joint systems as manufactured by US Pipe (Field Lok 350 Gaskets), American Pipe (Fast-Grip Gaskets), or an approved equivalent.
  - 2) Provide mechanical restrained joint fitting constructed of ductile iron and conforming to the material and performance requirements of AWWA C153. Assure all mechanical restrained joint fittings have seals conforming to ASTM F477 and the physical testing requirements of AWWA C111. Provide mechanical restrained joint fittings coated with fusion bonded epoxy coatings meeting the requirements of AWWA C116. Install all restrained joints in full conformance with manufacturer's recommendation, and assure the assembly of fitting joints does require beveling of the plain end of a cut pipe or the use of jacks or power equipment to force the pipe end past the gasket. Furnish mechanically restrained joint fittings as manufactured by One Bolt, Inc. (OneBolt), EBAA Iron, Inc. (Mega-Lug mechanical joint restraint), or an approved equivalent.

Add Sections 02660.2.2.B.6.b and c.

- b. Field verify material type and size to ensure that couplings will be sized for appropriate material and size.
- c. Furnish type (1) above coupling as manufactured by Romac Industries, Dresser Piping Specialties, or an approved equivalent.

Delete Section 02660.2.2.D Concrete Cylinder Pipe in its entirety

Add Section 02660.2.2.E.d.2.

- 2) For all polyethylene service pipe, assure corporation stops, curb stops, couplings, and all other fittings have pressure connections designed specifically for polyethylene pipe as manufactured by Mueller (Insta-Tite Connection Series) or an approved equivalent..

Delete Section 02660.2.8.A.1 and replace with the following.

- 1. Unless designated otherwise, valves 12 inches (30 cm) in diameter or smaller will be gate valves. Furnish iron body gate valves or resilient seat gate valves with non-rising stems with design, construction, and pressure rating meeting AWWA C509 and the following requirements.

Add Section 02660.2.8.A.4.

4. Furnish resilient seat gate valves as manufactured by Mueller, Clow, American Darling, or an approved equivalent.

Add Sections 02660.2.13.

Delete Sections 02660.3.2.A.3 and 4 and replace with the following.

3. Store all material safely and to prevent damage. Keep pipe interior and other accessories free from dirt and foreign matter at all times. If pipe is stored on site out of doors for more than 7 days, keep ends of pipe sealed against rodent intrusion and cover PVC pipe with protection from ultraviolet radiation from the sun.
4. Deliver and distribute all Contractor furnished pipe at the site. Load and unload pipe, fittings, specials, valves, and accessories to prevent damage. Do not permit pipe handled on skidways to skid or roll against pipe already on the ground. Do not make metal-to-metal contact between pipes or between fittings when moving or in storage, but rather use non-metal materials such as fire-hose. Do not drop pipe under any circumstance.

Delete Sections 02660.3.2.C.3 in its entirety.

Delete Sections 02660.3.2.C.7 and 8 and replace with the following.

7. Long radius curves, either horizontal or vertical, may be laid with ductile iron pipe using deflections at the joints when shown on the Drawings. Deflection at the joints is not to exceed 50 percent of manufacturer's recommended maximum deflection. PVC pipe may be deflected over the length of the pipe or at fittings when shown on the Drawings, based upon manufacturer's recommendations. The Contractor shall provide the Engineer all manufacturers' deflection requirements and warranty information that specifically states that deflection of pipe and fittings does not reduce or eliminate warranty coverage or pressure and safety ratings.
8. No additional payment will be made for laying pipe on planned curves, nor for field changes involving standard pipe lengths deflected at the joints or over the length of the pipe.

Add Section 02660.3.2.C.12.

12. Provide vertical fittings with thrust blocks one and a half times the sizes set forth in Standard Drawing 02660-1 and include 2 #5 rebar anchors bent around each fitting and set into the concrete.

Delete Section 02660.3.4.A.1 and replace with the following.

1. Perform hydrostatic and leakage testing in accordance with AWWA C600. Once the pipe is laid and backfilled, test for at least 2 hours, all newly laid pipe, or any valved section, at the highest point along the test section. Test to a hydrostatic pressure 2.0 times the normal operating pressure at the test point, but in no case less than a minimum gage pressure of 125 pounds per square inch (931 kPa) or

greater than the pressure rating of the pipe being tested. Do not test more than 1,000 linear feet (305 m) of pipeline at one time, unless otherwise approved by the Engineer.

Delete Section 02660.3.4.B.1 and replace with the following.

1. Before chlorination, flush the mains thoroughly after the pressure and leakage test are completed. Contractor is responsible for all permits, as may be required, associated with cleaning water mains and the entire disinfection process.

Delete Section 02660.3.4.C.2.a.3 in its entirety.

Delete Section 02660.3.4.C.3.a and replace with the following.

- a. Two (2) methods of chlorination may be used. The continuous feed method gives a 24 hour chlorine residual of not less than 25 parts per million (25 mg/L), and the slug method provides a 3 hour exposure of not less than 50 parts per million (50 mg/L) free chlorine.

Delete Section 02660.3.4.C.3.a.1 in its entirety.

Delete Section 02660.3.4.C.3.a.2.b and replace with the following.

- b) Use water from the existing distribution system or other approved source of supply to flow at a constant, measured rate in to the newly laid water main. At a point not more than 10 feet (3 m) downstream from the beginning of the new main, assure water entering the new main receives a dose of chlorine fed at a constant rate such that the water will have at least 50 parts per million (50 mg/L) free chlorine. To assure that this concentration is provided, measure the chlorine concentration at regular intervals.

Delete Section 02660.3.4.C.3.a.2.d and replace with the following.

- d) During chlorine application, position valves so that the chlorine solution in the main being treated does not flow into water mains in active service. Do not stop chlorine application until the entire main is filled with chlorinated water. Retain the chlorinated water in the main for at least 24 hours, operating all valves and hydrants in the section treated to disinfect the appurtenances. At the end of the 24 hour period, the treated water in all portions of the main must have a minimum free chlorine residual of 25 parts per million (25 mg/L).

Delete Section 02660.3.4.D.1 and replace with the following.

1. After final flushing and before the water main is placed in service, test a sample, or samples, collected from the main(s) for turbidity and bacteriological quality.



Collect at least one sample from the new main and one from each branch.  
Collect the samples and have the tests performed at an approved laboratory.

Add Section 026603.6.B.1.

1. Install gate valve boxes such that the tops are 3 inches (76 mm) below the finished grade in aggregate surfaced areas and at finished grade in asphalt surfaced areas. In unsurfaced areas, leave the top of gate valve boxes 6 inches (152 mm) above the existing grade and slope backfill to the top at a 4:1 slope.

Delete Section 02660.3.6.C.1 replace with the following.

1. For clarity thrust blocks have not been shown on Drawings, but install each valve with thrust blocking and anchor rods.

## **SM-02725 DRAINAGE CULVERTS**

Delete Sections 02725.2.1.E and replace with the following.

- E. Culverts shall not require headwalls, cutoff walls or end treatments unless noted in the plans or bid sheets.

Delete Sections 02725.3.1.A and replace with the following.

### **A-1 Excavation**

Excavate to permit removal, jointing, and backfilling of pipe. Construct and maintain the excavations to prevent personal injuries, damage to foundations, structures, pole lines, or other facilities. Pile and maintain all excavated material to meet OSHA requirements and with minimum inconvenience to the public. Do not excavate below the specified depth, unless approved by the Engineer. When excavation is complete, request approval by the Engineer as to the character and suitability of the foundation material. The foundation shall provide a firm foundation of uniform density throughout its length and width.

### **A-2 Bedding**

Place un-compacted bedding material over the foundation in a layer of uniform thickness. For pipe with diameters of 12 to 54 inches, the bedding thickness is 4 inches. For pipe diameters larger than 54 inches, the bedding thickness is 6 inches. For belled joints, recess the bedding to receive the joints. Place the culvert on un-compacted bedding layer. The bedding shall extend 18-inches beyond each side of the culvert unless otherwise noted on the plans. Furnish a well graded, free draining material free of excess moisture, muck, frozen lumps, roots, sod, or other deleterious material conforming to the following:

- Maximum particle size: 1/2 inch or half the corrugation depth, whichever is smaller
- Soil classification: AASHTO M 145 A-1, A-2-4, A-2-5, or A-3

### **A-3 Backfill**

Use equipment and methods for backfilling and compacting that do not distort, misalign, or damage the pipe. Place backfill in horizontal layers that, when compacted, do not exceed 6 inches in depth. Firmly tamp the backfill under the pipe haunches. Bring backfill up evenly on all sides of the structure, and extend each layer to the limits of the excavation or to natural ground. Backfill with soils conforming to the following unless otherwise noted on the plans:

- For all structures and pipes other than plastic pipe:  
Maximum particle size: 3 inches

Soil classification: AASHTO M 145 A-1, A-2, or A-3

- For plastic pipe:  
Maximum particle size: 1½ inches  
Soil classification: AASHTO M 145 A-1, A-2-4, A-2-5, or A-3

### **SM-03210 REINFORCING STEEL**

Delete Section 03210.2.1.A and replace with the following.

1. Furnish deformed reinforcement steel meeting ASTM A615, (AASHTO M31) or ASTM A705, Grade 60. Use only epoxy-coated reinforcement steel supplied by a CRSI certified epoxy-coated reinforcement steel manufacturer.

Delete Section 03210.3.3.A and replace with the following.

- A. Accurately place and hold firm all steel reinforcement in the plan locations, or as directed by Engineer, as concrete is being placed. Thrusting dowels into freshly poured concrete is prohibited.

Delete Section 03210.3.3.C and replace with the following.

- C. Overlap welded wire fabric for successive mats or rolls providing an overlap measured between outermost cross wires of each fabric sheet not less than the greatest spacing of the cross wires plus 2 inches (50 mm) but not less than 6 inches (150 mm), whichever is greater. Extend the fabric across supporting beams and walls to within 4 inches (100 mm) of concrete edges. It may extend through contraction joints. Adequately support the fabric during concrete placement to maintain its position in the slab using the methods previously described or by laying the fabric on a concrete layer of the required depth before placing the upper slab layer.

Delete Section 03210.3.3.G and replace with the following.

- G. Follow the minimum concrete protective covering for reinforcement below, unless noted otherwise on the Drawings.

### **SM-03310 STRUCTURAL CONCRETE**

Delete Section 03310.1.3.B and replace with the following.

- B. Employ, at the Contractor's expense, a testing laboratory acceptable to the Engineer to perform material evaluation tests, the mix design prior to placing any concrete, and all acceptance testing during the onsite placement of the concrete. Retesting or additional testing of concrete or materials failing to meet the requirements of these specifications must be done by the Contractor at no additional cost to the Owner.

Add the following to Section 03310.2.2.B.4.

- B. Severe exposure shall be used to determine the required air content.

Amend the footnote for Table 2.2 in Section 03310.2.2.B.4 to read the following.

\*Air content tolerance is plus two percent (+2%) to minus one percent (-1%).

Modify the first sentence of Section 03310.2.2.B.4.c.3

The combined weight of fly ash and pozzolan meeting ASTM C618 cannot exceed 15 percent of the total weight.

Modify the last sentence of Section 03310.2.2.B.4.c.5

Fly ash or pozzolan must not constitute more than 15 percent of the total weight of cementitious material.

Delete Section 03310.3.7.A. and replace with the following.

- A. All concrete must be tested by an ACI Grade I or equivalent certified testing technician. Unless otherwise specified, the Contractor shall be responsible for all acceptance testing during the on-site placement of the concrete.

Delete Section 03310.3.7.A.2.a and replace with the following.

- a. During each day's pour, check the consistency of the concrete by slump test. Also perform a slump test each time a test cylinder is made. Assure slump tests meet ASTM C143 "Method of Test for the Slump of Portland Cement Concrete."

Delete Section 03310.3.7.A.3.h and replace with the following.

- h. When concrete fails to meet the requirements above or when tests of field cured cylinders indicate deficiencies in protection and curing, the Contractor may order tests on the hardened concrete under Chapter 17.3 of ACI-301-84 or load tests in Chapter 20 of the ACI Building Code (ACI 318-83) for that portion of the structure where the questionable concrete has been placed. In the event the load or core tests also indicate that the structure is unsatisfactory, make all modifications as directed by the Engineer to make the structure sound.

Delete Section 03310.3.7.A.4.a and replace with the following.

- a. During each strength test, check the air content by either ASTM C231 "Method of Test for Air Content of Freshly Mixed Concrete by the

Pressure Method, ASTM C173 “Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method”, or ASTM C138 “Method of Test for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.”

Add Sections 03310.4.2.A.2 and 3.

2. Concrete producers are to allow access to their facilities by Owner or Owner’s representative for inspecting their facilities and/or sampling materials. Assure all facilities meet the requirements of the “National Ready-Mix Concrete Association” check list for concrete production facilities.
3. Items directly affecting a facility’s ability to properly proportion, transport, and deliver concrete may be reason for disqualifying that facility as a source of supply until such deficiencies are corrected. Examples would include cement and aggregate scales that will not accurately weigh materials or mixer units which will not thoroughly mix concrete materials.

Amend the first line and note of Table 4.1 in Section 03310.4.2.D to read the following.

SUBMITTAL	FREQUENCY		
	Monthly	Twice Yearly	Other
Complete Mix Design			Annually, or see 4.2.B.3a

Note: The monthly reports indicated above will not be required during non-production months. Frequency of submittals may change as dictated by variations of test data.

**END OF SECTION**

# **DIVISION 1**

## **GENERAL REQUIREMENTS**

## **SECTION 01275**

### **MEASUREMENT AND PAYMENT**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and Special Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

##### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for measurement and payment.

##### **1.3 DEFINITIONS**

- A. Unit price is an amount proposed by bidders, stated on the Bid Form, as a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

##### **1.4 PROCEDURES**

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.
- B. Measurement and Payment: The Measurement and Payment sections do not necessarily name all incidental items required to complete the work. The cost of all such incidentals shall be included in the various related items of work. All estimated quantities stipulated in the Bid Forms or other Contract Documents are approximate and are to be used only as a basis for estimating the probable cost of the work and for the purpose of comparing the proposals submitted for the work. It is understood and agreed that the actual amounts of work performed and materials furnished under unit price items may differ from such estimated quantities and the payment for such work and materials shall be based on the actual amount of work done and materials furnished in each case.
- C. Engineer will determine the actual quantities and classifications of Unit Price Work performed by the Contractor.
- D. List of Bid Items: A list of unit Bid Items is included at the end of this Section. Specification Sections referenced in the schedule contain requirements for materials described under each Bid Item.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 LIST BID ITEMS

#### A. Bid Item No. 1- MOBILIZATION

1. Description: This item covers the costs of preparatory work and operations. **Any bids that contain a lump sum bid price for mobilization greater than 10% of the bid price for the respective schedule or additive alternative may be rejected at the option of the Owner.**
2. Work Required: Work required under this section includes but is not limited to the following.
  - a. The movement of personnel, equipment, supplies and incidentals to the project site
  - b. The establishment of all facilities necessary for the work on the project;
  - c. The costs of obtaining the required permits, bonds, and insurance; and
  - d. All other work and operations which must be performed, or costs incurred prior to beginning work on the various items of the project.
3. Unit of Measurement: Lump Sum
4. Measurement: Measurement for MOBILIZATION will be made as a percentage completed of the lump sum. 50% of the lump sum will be credited to the first progress payment, with the second 50% being credited to subsequent progress payments in proportion to total construction completed as a percentage of the contract unit price.  
Payment: Payment for MOBILIZATION will be made at the contract unit price bid as a lump sum.

#### B. Bid Item No. 2 – CLEAR & GRUB

1. Description: This item shall cover the costs associated with the removal and legal disposal of any vegetation and trees that are in conflict with the proposed work.
2. Work Required: Work required under this section shall include but not be limited to the following:
  - a. Removal of selected trees and shrubs within the selected transmission main alignment for a maximum 8 ft. clearing width;
  - b. Off haul and disposal of removed vegetative debris;
  - c. Disposal of excess or unsuitable vegetative material: All construction debris and excess excavated material shall be disposed of off-site. The Contractor is responsible for all disposal fees as applicable. No burning of materials on the project site will be allowed.
  - d. All labor, tools, equipment, materials, royalties, incidentals necessary to complete the work as specified.
3. Unit of Measurement: ACRE
4. Measurement: per acre of clearing area measured in place
5. Payment: Payment for CLEAR & GRUB will be made at the contract unit price bid per acre as indicated in the Bid Form.

#### C. Bid Item No. 3 - EXPLORATORY EXCAVATION

1. Description: Exploratory excavation will be used as a convenience to the Owner and/or Engineer when a subsurface condition needs to be verified.

2. Work Required: Work required under this section includes but is not limited to the following.
  - a. Furnishing a fueled excavator with an experienced operator and a laborer with shovel to excavate and backfill as directed; and
  - b. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
3. Unit of Measurement: HOUR
4. Measurement: Measurement for EXPLORATORY EXCAVATION will be made by the hour, rounded to the nearest one-half hour, for exploratory excavation authorized by the Engineer. The time will start when excavation begins and end when backfill has been completed. Time will be deducted for mechanical breakdowns.

Payment: Payment for EXPLORATORY EXCAVATION will be made at the contract unit price bid per hour.

D. Bid Item No. 4 – STRIP, STOCKPILE AND REPLACE TOPSOIL

1. Description: This item includes stripping, stockpiling and replacing topsoil within the grading limits of the proposed access road embankment and indicated on the drawings.
2. Work Required: Work required under this section includes but is not limited to the following.
  - a. Removing grass before stripping;
  - b. Stripping topsoil from all areas which will be disturbed within the construction limits and stockpiling it;
  - c. Strip topsoil to the depth needed to prevent intermingling with underlying subsoil or other waste material;
  - d. Shaping of topsoil to drain surface water for duration of stockpile;
  - e. Re-apply and evenly distribute the stockpiled topsoil to the sloped access road embankments to a minimum depth of 4 inches or until the topsoil stockpile is depleted; and,
  - f. All incidental materials, tools, equipment, and labor for the completion of this item.
3. Unit of Measurement: LUMP SUM
4. Measurement: Not applicable.
5. Payment: Payment for STRIP, STOCKPILE, AND REPLACE TOPSOIL will be made at the contract unit price bid per lump sum.

E. Bid Item No. 5 – DEMO/REMOVE EXISTING CONCRETE PUMP SITE CISTERN

1. Description: This item shall cover the costs associated with the removal and legal disposal of the existing concrete cistern and items indicated on the drawings.
2. Work Required: Work required under this section shall include but not be limited to the following:
  - a. Strip and remove existing siding and insulation;
  - b. Concrete demolition and removal;
  - c. Excavate and remove tank foundation material;
  - d. Disconnect existing 2" spring supply pipe;
  - e. Salvage of any items per the direction of FWP;
  - f. Remove existing cistern drain pipes and outfalls;
  - g. Haul and dispose of materials to a location off of FWP property for all existing concrete cistern elements not salvaged to FWP;
  - h. Re-grade site to drain after removal



- i. Providing and compacting fill material as necessary;
    - j. All labor, tools, equipment, materials, royalties, incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Not applicable.
  - 5. Payment: Payment for DEMO/REMOVE EXISTING CONCRETE PUMP SITE CISTERN will be made at the contract unit price bid per lump sum as indicated in the Bid Form.
- F. Bid Item No. 6 – DEMO/REMOVE EXISTING PUMP HOUSE BLDG.
- 1. Description: This item shall cover the costs associated with the removal and legal disposal of the existing pump house and items indicated on the drawings.
  - 2. Work Required: Work required under this section shall include but not be limited to the following:
    - a. Wood framed building demolition;
    - b. Excavate and remove existing building foundation material to a minimum 12” below the bottom of the existing building floor slab;
    - c. Drain, disconnect and temporarily cap existing 1.5” galvanized storage tank supply pipe;
    - d. Drain, disconnect and temporarily cap the existing picnic area water supply pipes;
    - e. Salvage any items including pipes, pumps, fittings, storage closets, electrical, etc. per the direction of FWP.
    - f. Remove existing building drain pipes and outfalls;
    - g. Haul and dispose of materials to a location off of FWP property for all existing building elements not salvaged to FWP;
    - h. All labor, tools, equipment, materials, royalties, incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Not applicable.
  - 5. Payment: Payment for DEMO/REMOVE EXISTING PUMP HOUSE BLDG will be made at the contract unit price bid per lump sum as indicated in the Bid Form.
- G. Bid Item No. 7 – CUT, PLUG AND ABANDON EXISTING SPRING SUPPLY PIPE:
- 1. Description: As shown on the Drawings, the existing 2” Spring Supply water main (from the existing spring box to the pump building) shall be abandoned in-place. Nothing more will be required of the main. Cut the old main back, and either cap or plug with a fitting designed for the purpose or fill in and around the pipe end with one quarter yard of concrete.
  - 2. Work Required: Work required under this section shall include but not be limited to the following.
    - a. Trench excavation to expose existing pipe, backfill, and compaction;
    - b. Cutting existing pipe;
    - c. Furnishing and installing concrete or pipe end cap fitting to plug pipe ends; and,
    - d. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Not Applicable.

5. Payment: Payment will be lump sum for CUT, PLUG AND ABANDON EXISTING SPRING SUPPLY PIPE as indicated in the Bid Form.
- H. Bid Item No. 8 – ACCESS ROAD EMBANKMENT
1. Description: This item includes providing, placing, and compacting access road embankment.
  2. Work Required: Work required under this section includes but is not limited to the following.
    - a. Traffic control;
    - b. Having readily available, a minimum amount of imported suitable embankment material to avoid time delays in construction;
    - c. Submitting material test reports of the intended borrow source from a qualified testing laboratory and showing material conformance to Section 02300 of the Specifications;
    - d. Furnishing and placing the road embankment material;
    - e. Watering, placing and compacting of subgrade as specified; and,
    - f. All incidental materials, tools, equipment, and labor for the completion of this item.
  3. Unit of Measurement: CUBIC YARD
  4. Measurement: Measurement for ACCESS ROAD EMBANKMENT will be made per placed cubic yard.
  5. Payment: Payment for ACCESS ROAD EMBANKMENT will be made at the contract unit price bid per cubic yard.
- I. Bid Item No. 9– ACCESS ROAD ¾” MINUS ROAD BASE
1. Description: This item covers providing, placing, and compacting of the access road base as indicated on the Drawings and in the Contract Documents.
  2. Work Required: Work required under this section includes but is not limited to the following.
    - a. Traffic control;
    - b. Watering, processing and compaction of material;
    - c. Furnishing and installing ¾” minus road base within the limits and a minimum thickness of 6-inches as indicated on the drawings;
    - d. Submitting material test reports of the material source from a qualified testing laboratory and showing material conformance to Section 02235 of the MPW Standard Specifications; and
    - e. All labor, tools, equipment, materials, royalties and incidentals necessary to complete the work as specified.
  3. Unit of Measurement: CUBIC YARD
  4. Measurement: Measurement for ACCESS ROAD ¾” MINUS ROAD BASE will be made per cubic yard.
  5. Payment: Payment for ACCESS ROAD ¾” MINUS ROAD BASE will be made at the contract unit price bid per cubic yard.
- J. Bid Item No. 10 – 36” CMP ACCESS ROAD CULVERT W/ FLARED END SECTIONS:
1. Description: This item covers providing and installing the access road culvert for the Greer Gulch to the lines and grades as indicated on the drawings.
  2. Work required under this section shall include but not be limited to the following:

- a. Furnishing, excavating, placement, and backfilling of the culverts at the locations shown on drawings;
    - b. Meet the requirements of Section 02725 of the MPW Standard Specifications;
    - c. Installation of CMP flared end sections on the upstream and downstream ends of the culvert; and,
    - d. All labor, tools, equipment, materials, royalties, incidentals necessary to complete the work as specified.
  3. Unit of Measurement: LINEAL FOOT
  4. Measurement: Measurement for 36" CMP ACCESS ROAD CULVERT W/ FLARED END SECTIONS: will be per Lineal Foot as indicated in the Bid Form and as shown on the plans.
  5. Payment: Payment for 36" CMP ACCESS ROAD CULVERT W/ FLARED END SECTIONS: will be made at the contract unit price bid per Lineal Foot as indicated in the Bid Form.
- K. Bid Items No. 11 – 2" HDPE SPRING SUPPLY PIPE
1. Description: HDPE water main in sizes indicated on the drawings and in the contract documents.
  2. Work Required: Work required under this section shall include but not be limited to the following:
    - a. Trench excavation, bedding, backfill, and compaction;
    - b. Dewatering, sheeting, and shoring required for installation;
    - c. Furnishing and installing pipe and fused joints;
    - d. Furnishing and installing all required fused and mechanical fittings, gaskets, lubricants, etc;
    - e. Furnishing and installing appropriate detection wire;
    - f. Furnishing and installing bedding;
    - g. Testing, cleaning and disinfecting; and,
    - h. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  3. Unit of Measurement: LINEAL FOOT
  4. Measurement: 2" HDPE SPRING SUPPLY PIPE will be measured per lineal foot along the centerline of the pipe through all valves, fittings, and appurtenances as indicated in the Bid Form.
  5. Payment: Payment will be made at the contract price bid per lineal foot of the various sizes and classes of 2" HDPE SPRING SUPPLY PIPE as indicated in the Bid Form and shall include the cost of trench excavation and backfill.
- L. Bid Items No. 12 and 13 – GATE VALVE WITH VALVE BOX:
1. Description: Gate valves with valve boxes in sizes indicated on the drawings upstream of the underground storage cistern.
  2. Work Required: Work required under this section shall include but not be limited to the following:
    - a. Additional excavation, bedding, backfill and compaction;
    - b. Furnishing and installing the gate valve and box;
    - c. Additional couplings required;
    - d. Dewatering, sheeting, and shoring required for installation;
    - e. Furnishing and installing polyethylene wrap;
    - f. Disinfection and testing; and,

- g. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: EACH
  - 4. Measurement: GATE VALVE AND VALVE BOX will be measured per each for each size of gate valve specified.
  - 5. Payment: Payment will be made at the contract unit price bid for each size and type of GATE VALVE WITH VALVE BOX as specified in the Bid Form.
- M. Bid Item No. 14 – NEW PUMP HOUSE BUILDING & SITEWORK:
- 1. Description: This item shall include the construction of a new concrete construction utility pump house building. The building will house piping, valves, disinfection equipment, electrical panels and storage space.
  - 2. Work Required: Work required under this section shall include but not be limited to the following:
    - a. Site Preparation;
    - b. Structural excavation and backfill;
    - c. Site Grading;
    - d. Placement of 12-inches min. bedding under the floor;
    - e. Furnishing and installing a new insulated concrete construction utility pump house building as shown on the contract drawings;
    - f. Provide wood texture concrete exterior;
    - g. Furnishing and installing a single lockable steel door and finish hardware;
    - h. Furnish and installation of the steel utility closet as shown on the drawings;
    - i. Furnish and installation of HVAC and mechanical equipment;
    - j. Shop drawings and submittals;
    - k. Providing slopes to floor drain;
    - l. Providing rough openings in the floor and walls as required to accept mechanical and electrical equipment;
    - m. Providing exterior concrete splash pad;
    - n. Provide wall and roof sandwich panel insulation;
    - o. Installation of the floor drain, 4" PVC drain line with 24 mesh screen at end, and drain rock rip rap outfall as shown on the drawings;
    - p. Installation of the 4" exterior concrete slab placed in front of the entry door; and,
    - q. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Measurement for the NEW WELL HOUSE BUILDING & SITEWORK will be by lump sum.
  - 5. Payment: Payment for the NEW WELL HOUSE BUILDING & SITEWORK will be made at the contract unit price bid per lump sum as indicated in the Bid Form.
- N. Bid Item No. 15 – PUMP HOUSE PIPING, VALVES, FITTINGS, PUMPS & DISINFECTION EQUIPMENT :
- 1. Description: This item shall include all piping, valves, fittings, booster pumps & disinfection equipment located within the pump house building and all pipe connections for supply pipes as shown on the drawings.

2. Work Required: Work required under this section shall include, but not be limited to the following:
  - a. Furnishing and installing miscellaneous fittings and piping including tees and threaded couplings, crosses, reducers of the types and sizes shown on the plans
  - b. Furnishing and installing the surge tank;
  - c. Furnishing and installing the check valves;
  - d. Furnishing and installing the gate valves;
  - e. Furnishing and installing the flow meter;
  - f. Furnishing and installing the pressure reducing valves;
  - g. Furnishing and installing the air/vacuum valves;
  - h. Furnishing and installing pipe supports;
  - i. Furnishing and installing pressure gauges;
  - j. Furnishing and installing sample taps;
  - k. Sealing all pipe penetrations;
  - l. Shop drawings and submittals;
  - m. Installing concrete equipment support blocks as needed to support equipment;
  - n. Furnishing and installing 5 and 1 micron cartridge filters;
  - o. Furnishing and installing booster pumps;
  - p. Installation of chlorination equipment including chlorine tanks and chemical metering pumps;
  - q. Furnishing portable chlorine testing equipment to Owner as specified;
  - r. Installation of U.V. disinfection system not including electrical related work;
  - s. U.V. System spare parts;
  - t. Placement of the 2" galvanized above-ground winterization drain and 24 mesh screen at outfall;
  - u. Furnish and Installation of minimum 30 lineal feet of buried 6" PVC loop.
  - v. Providing disinfection and testing of the system;
  - w. Providing operation and maintenance manuals;
  - x. Providing necessary painting of all piping and valves;
  - y. Reconnection to the existing picnic area supply pipe and 1.5" galvanized storage tank supply pipes;
  - z. Connection to the 2" pump supply pipes; and,
  - aa. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
3. Unit of Measurement: LUMP SUM
4. Measurement: Measurement for the PUMP HOUSE PIPING, VALVES, FITTINGS, PUMPS & DISINFECTION EQUIPMENT will be by Lump Sum.
5. Payment: Payment for the PUMP HOUSE PIPING, VALVES, FITTINGS, PUMPS & DISINFECTION EQUIPMENT will be made at the contract unit price bid per lump sum as indicated in the Bid Form.

O. Bid Item No. 16 - NEW 5000 GAL. UNDERGROUND REINFORCED FIBERGLASS STORAGE CISTERN:

1. Description: This item shall include the furnishing and installation of a buried, fiberglass water storage tank and all piping, valves, fittings, excavation, grading, and other work required to prepare the cistern installation.

2. Work Required: The work required under this section shall include but not be limited to the following:
  - a. Excavation and embankment;
  - b. Disposal of debris and excess material;
  - c. Furnishing and installing the fiberglass water storage tanks, complete with accessories as shown in the specifications and drawings;
  - d. Furnish and installation of submersible pumps, pump casings, flex hoses and outlet nozzles compatible with the tank;
  - e. Furnish and installation of 4" gate valve and box on 4" PVC tank drain;
  - f. Placement of 4" tank drain line and outfall;
  - g. Furnish and installation of 2" gate valve and box on 2" HDPE tank overflow;
  - h. Placement of 2" HDPE pump feed lines to the pump house building and associated connections;
  - i. Providing flanged couplings for well casings, overflow line, drain pipe and supply pipes as shown on the drawings;
  - j. Installation of pea gravel bedding and placement of geotextile fabric as shown on the drawings;
  - k. Connection to 2" HDPE spring water supply and bypass pipes;
  - l. Installation of the 2" HDPE bypass pipes and outfall;
  - m. Cleaning and disinfection of tank;
  - n. Furnishing and installation of submersible pumps, pitless adapters, flexible hose and couplings as shown on the drawings;
  - o. Installation of access ladder and hatch;
  - p. Submittals in accordance with Section 13200; and,
  - q. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
3. Unit of Measurement: LUMP SUM
4. Measurement: Measurement for the NEW 5000 GAL. UNDERGROUND REINFORCED FIBERGLASS STORAGE CISTERN will be per lump sum as indicated in the Bid Form.
5. Payment: Payment for the NEW 5000 GAL. UNDERGROUND REINFORCED FIBERGLASS STORAGE CISTERN will be made at the contract unit price bid per lump sum as indicated in the Bid Form.

P. Bid Item No. 17 - CLEAN AND DISINFECT EXISTING SPRING BOX:

1. Description: This item shall include the dewatering, cleaning and disinfect the existing spring box and inlet pipe per SP-22.
2. Work Required: The work required under this section shall include but not be limited to the following:
  - a. Providing temporary plugging of the existing 3" cast iron spring supply inlet to the cistern for maintaining a dry environment in the cistern for cleaning and disinfection;
  - b. Dewatering cistern;
  - c. Cleaning and removal sediment and debris;
  - d. High pressure water jet all walls, floor and ceiling;
  - e. Disinfecting the cistern per SP-22.
  - f. Providing safety measures for work performed within a confined space;
  - g. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
3. Unit of Measurement: LUMP SUM

4. Measurement: Measurement for the CLEAN AND INSPECT EXISTING SPRING BOX will be per lump sum as indicated in the Bid Form.
5. Payment: Payment for the CLEAN AND INSPECT EXISTING SPRING BOX will be made at the contract unit price bid per lump sum as indicated in the Bid Form.

Q. Bid Item No. 18 - REHABILITATION OF EXISTING SPRING BOX:

1. Description: This item shall include the rehabilitation of the existing concrete spring box.
2. Work Required: The work required under this section shall include but not be limited to the following:
  - a. Plugging existing 3" cast iron spring supply inlet to the cistern.
  - b. Dewatering and drying cistern;
  - c. Providing safety measures for work performed within a confined space;
  - d. Excavate for positive drainage away from cistern as shown on the drawings;
  - e. Removal of existing siding and roofing;
  - f. Connecting to the new 2" HDPE outlet water supply as shown on the drawings;
  - g. Replacing the existing 3" CIP with new 3" HDPE from the spring box to the inlet side gate valve;
  - h. Connecting to the new 3" HDPE inlet pipe as shown on the drawings;
  - i. Installation of new siding, roofing and insulation as shown on the drawings;
  - j. Furnishing and installing a new 1/8" steel cover with attached vent screen;
  - k. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
3. Unit of Measurement: LUMP SUM
4. Measurement: Measurement for the REHABILITATION OF EXISTING SPRING BOX will be lump sum as indicated in the Bid Form.
5. Payment: Payment for the REHABILITATION OF EXISTING SPRING BOX will be made at the contract unit price bid per lump sum as indicated in the Bid Form.

R. Bid Item No. 19 – REPLACE EXISTING 6" MJ x FL GATE VALVE AT STORAGE TANK:

1. Description: This item includes replacing the existing faulty outlet-side gate valve at the outlet side of the existing water storage tank. The gate valve is located mostly above ground.
2. Work Required: Work required under this section shall include but not be limited to the following:
  - a. Excavation as needed to expose and retrieve existing valve;
  - b. Furnishing and installing the gate valve;
  - c. Submittals;
  - d. Draining tank;
  - e. Additional couplings as required;
  - f. Salvage any items per FWP;
  - g. Furnishing and installing polyethylene wrap;
  - h. Disinfection and testing;

- i. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: REPLACE EXISTING 6" MJ x FL GATE VALVE AT STORAGE TANK will be measured per lump sum for the size of gate valve specified.
  - 5. Payment: Payment will be made at the contract unit price bid lump sum for REPLACE EXISTING 6" MJ x FL GATE VALVE AT STORAGE TANK as specified in the Bid Form.
- S. Bid Item No. 20 – BLOW OUT VAULT ASSEMBLY:
- 1. Description: This section shall include a new blow vault assembly, as shown on the drawings, and tied into the new spring supply pipe line. This item shall also includes up to ten feet of outfall pipe and rock outfall to Greer Gulch as shown on the drawings.
  - 2. Work Required: Work required under this section shall include but not be limited to the following:
    - a. Dewatering, sheeting, and shoring;
    - b. Excavation, bedding, backfill and compaction around the vault;
    - c. Furnishing and installing new blow out vault, pipe, and valves;
    - d. Installing up to 10 feet of HDPE outfall pipe, outfall drain rock and mesh screen on pipe;
    - e. Installing pipe supports;
    - f. Furnishing and installing CMP vault casing and well cover lid;
    - g. Pipe and fittings as shown on the contract drawings including cross, valves and air connection (fittings and valves within vault to be brass);
    - h. Furnishing and installing drain gravel;
    - i. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: BLOWOUT VAULT ASSEMBLY will be lump sum.
  - 5. Payment: Payment will be made at the contract unit price bid per lump sum for BLOWOUT VAULT ASSEMBLY.
- T. Bid Item No. 21– CONTROLLED ACCESS GATE
- 1. Description: This item consists of the installation of a restricted access gate in size, type and location as indicated on the drawings.
  - 2. Work Required: Work required under this section includes but is not limited to the following.
    - a. Site preparation;
    - b. Traffic Control;
    - c. Furnishing concrete for gate posts;
    - d. Installing gate posts;
    - e. Furnishing and installing steel gates as shown on the drawings;
    - f. Painting the gate and posts;
    - g. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  - 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Measurement for CONTROLLED ACCESS GATE will be lump sum.



5. Payment: Payment for CONTROLLED ACCESS GATE will be made at the contract unit price of lump sum.
6. Bid Item No. 22 – BOLLARDS
  1. Description: This item includes installation of new traffic bollards around the buried storage tank.
  2. Work required under this section shall include but not be limited to the following:
    - a. Excavation, bedding, backfill and compaction around the bollard;
    - b. Furnish and installation of 6" diameter steel pipe;
    - c. Grouting the inside of the steel pipe;
    - d. Installation of concrete base;
    - e. Painting of all exposed steel;
    - f. All labor, tools, equipment, materials, royalties, incidentals necessary to complete the work as specified;
  3. Unit of Measurement: EACH
  4. Measurement: Measurement for BOLLARDS will be per EACH as indicated in the Bid Form.
  5. Payment: Payment for BOLLARDS will be made at the contract unit price bid per EACH as indicated in the Bid Form.
- U. Bid Item No. 23 – SEED & FERTILIZE
  1. Description: This item included seeding and fertilizing, with approved mixtures, all areas that the Contractor disturbs, which may include but is not limited to include haul roads, pipe routes, spoil areas, equipment areas, borrow areas, material storage areas.
  2. Work Required: Work required under this section includes but is not limited to the following.
    - a. Seed bed preparation;
    - b. Seeding and fertilizing the disturbed areas;
    - c. Protection of the seeded areas and reseeding as required during the maintenance period;
    - d. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
  3. Unit of Measurement: LUMP SUM
  4. Measurement: Measurement for SEED & FERTILIZE will be made as a percentage completed of the lump sum.
  5. Payment: Payment for SEED & FERTILIZE will be made at the contract unit price bid as a lump sum.
- V. Bid Item No. 24 – ELECTRICAL
  1. Description: This item includes all electrical requirements needed for the pump house building, pumps and equipment as indicated on the drawings and in the Contract Documents.
  2. Work Required: The work required under this section includes but is not limited to the following.
    - a. Coordinating with Northwestern Energy to complete service application and to provide electrical service;
    - b. Preparation and submitting electrical circuit and load schedule charts;
    - c. Furnishing and installing electrical service and disconnect;

- d. Furnishing and installing new meter base, control panels and other site electrical work;
  - e. Furnishing and installing all necessary panels, heaters, conduit, wire and fixtures for new pumps, structure, UV unit, flow meter and chemical meter pumps;
  - f. Furnishing and installing conduit and wiring from submersible pumps located within the reinforced fiberglass storage cistern to electrical panels in the pump house;
  - g. Furnishing and installing power to the louver and exhaust fan;
  - h. Furnishing and installing new motor control center at the new pump house complete with appropriate enclosure, motor starters equipped with VFD technology, controls, relays, etc.;
  - i. Coordinating with the installation of the supervisory control system;
  - j. Providing operation and maintenance manuals;
  - k. Providing start up services and operator training as needed;
  - l. Furnishing and installing exterior and interior lighting as shown on the drawings;
  - m. Providing operation and maintenance manuals for all equipment; and
  - n. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
- 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Measurement for the ELECTRICAL will be made as a percentage completed of the lump sum.
  - 5. Payment: Payment for the ELECTRICAL will be made at the contract unit price bid as a lump sum.

W. Bid Item No. 25 – SUPERVISORY CONTROL SYSTEM:

- 1. Description: This item includes the installation, startup and training for a supervisory control system. The Contractor shall be prepared to connect the new telemetry system to the electrical and piping systems at the pump house. The Contractor shall provide a minimum of eight hours of training by an acceptable representative of the telemetry control system. Onsite startup and troubleshooting does not constitute training.
- 2. Work Required: The work required under this section shall include, but not be limited to the following:
  - a. Furnishing and installing new master telemetry control panel at the new pump house with telemetry control equipment, hands-off-auto switches, meters, level controller, alarm lights, auto dialer, touchscreen computer system, etc.;
  - b. Furnishing and installing new remote telemetry control panel and transducer at the existing storage tank with connection to the new master telemetry control panel via radio signal;
  - c. Furnishing and installing new remote telemetry control panel at the Visitor Center with connection to the remote telemetry control panel at the tank via radio signal.
  - d. Antennas, modems, wire or other equipment necessary to insure a reliable signal between the master panel and remote units;
  - e. Providing critical function inputs for UV system and future continuous chlorine and turbidity monitors;
  - f. Coordination with the antenna tower manufacturer for mounting the antenna for the RTU's at the tank site and the visitor center;

- g. Providing start-up services and operator training;
  - h. Paying for and obtaining necessary federal and state licenses and permits for radio telemetry system;
  - i. Providing operation and maintenance manuals;
  - j. Coordinating to have telephone service installed to the new pump house for operation of the auto dialer;
  - k. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
- 3. Unit of Measurement: LUMP SUM
  - 4. Measurement: Measurement for the SUPERVISORY CONTROL SYSTEM will be by lump sum at the contract unit price as indicated in the Bid Form.
  - 5. Payment: Payment for SUPERVISORY CONTROL SYSTEM will be made on the percentage of the contract unit price bid per lump sum as indicated in the Bid Form.

X. Additive Alternate Bid Item No. 1.A – REMOVE & REPLACE EXISTING 1.5” GALV. TRANSMISSION PIPE

- 1. Description: This item includes the removal and replacement of the existing above ground 1.5” galvanized pipe which is currently routed from the pump house to the existing storage tank. Much of the existing pipe is placed along rough and steep terrain.
- 2. Work Required: Work required under this section shall include but not be limited to the following:
  - a. Removal and disposal of existing galvanized piping and salvage of any items per FWP;
  - b. Furnishing and installing pipe and joints;
  - c. Installing the pipe along the same alignment as the existing pipe;
  - d. Providing and installing pipe supports as necessary;
  - e. Connecting to and providing all necessary fittings and adapters necessary to connect to the existing water storage tank;
  - f. Testing, cleaning and disinfecting;
  - g. All labor, tools, equipment, materials, royalties, and incidentals necessary to complete the work as specified.
- 3. Unit of Measurement: LINEAL FOOT
- 4. Measurement: – REMOVE & REPLACE EXISTING 1.5” GALV. TRANSMISSION PIPE will be measured per lineal foot along the centerline of the pipe through all valves, fittings, and appurtenances as indicated in the Bid Form.
- 5. Payment: Payment will be made at the contract price bid per lineal foot installed and measured in place for the item– REMOVE & REPLACE EXISTING 1.5” GALV. TRANSMISSION PIPE as indicated in the Bid Form.

**END OF SECTION**

## **SECTION 01300**

### **SUBMITTALS**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and Special Provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

##### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

##### **1.3 DEFINITIONS**

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

##### **1.4 SUBMITTAL PROCEDURES**

- A. General: Electronic copies of CAD Drawings of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Direct Transmittal from Prime Contractor: Engineer will not accept submittals from anyone but the Prime Contractor.
- D. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
  2. Allow 15 days for processing each resubmittal.
  3. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- E. Identification: Place a permanent label or title block on each submittal for identification.
1. Indicate name of firm or entity that prepared each submittal on label or title block.
  2. Provide a space approximately 4 by 5 inches (100 by 125 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
  3. Include the following information on label for processing and recording action taken:
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Unique identifier, including revision number.
    - i. Number and title of appropriate Specification Section.
- F. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- G. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.
- H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Engineer will discard submittals received from sources other than Contractor.
1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
  2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.
  3. Transmittal Form: Provide locations on form for the following information:
    - a. Project name.
    - b. Date.
    - c. Destination (To:).
    - d. Source (From:).
    - e. Names of subcontractor, manufacturer, and supplier.
    - f. Category and type of submittal.
    - g. Submittal purpose and description.

- h. Submittal and transmittal distribution record.
  - i. Remarks.
  - j. Signature of transmitter.
- I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- J. Use for Construction: Use only final submittals with mark indicating action taken by Engineer in connection with construction.

## **PART 2 - PRODUCTS**

### **2.1 ACTION SUBMITTALS**

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
  - 1. Number of Copies: Submit five copies of each submittal, unless otherwise indicated. Engineer will return two copies. Mark up and retain one returned copy as a Project Record Document.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.
  - 3. Include the following information, as applicable:
    - a. Manufacturer's written recommendations.
    - b. Manufacturer's product specifications.
    - c. Manufacturer's installation instructions.
    - d. Standard color charts.
    - e. Manufacturer's catalog cuts.
    - f. Wiring diagrams showing factory-installed wiring.
    - g. Printed performance curves.
    - h. Operational range diagrams.
    - i. Mill reports.
    - j. Standard product operating and maintenance manuals.
    - k. Compliance with recognized trade association standards.
    - l. Compliance with recognized testing agency standards.
    - m. Application of testing agency labels and seals.
    - n. Notation of coordination requirements.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
  - 1. Preparation: Include the following information, as applicable:
    - a. Dimensions.
    - b. Identification of products.

- c. Fabrication and installation drawings.
  - d. Roughing-in and setting diagrams.
  - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
  - f. Shopwork manufacturing instructions.
  - g. Templates and patterns.
  - h. Schedules.
  - i. Design calculations.
  - j. Compliance with specified standards.
  - k. Notation of coordination requirements.
  - l. Notation of dimensions established by field measurement.
- 2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
  - 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).
- D. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
- 1. Name, address, and telephone number of entity performing subcontract or supplying products.
  - 2. Number and title of related Specification Section(s) covered by subcontract.
  - 3. Drawing number and detail references, as appropriate, covered by subcontract.

## 2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
- 1. Number of Copies: Submit two copies of each submittal, unless otherwise indicated. Engineer will not return copies.
  - 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.
- C. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.
- D. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

- E. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- F. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- G. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- H. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.
- I. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- J. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- L. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment.
- M. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- N. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
  - 1. Preparation of substrates.
  - 2. Required substrate tolerances.
  - 3. Sequence of installation or erection.
  - 4. Required installation tolerances.
  - 5. Required adjustments.
  - 6. Recommendations for cleaning and protection.



- O. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
  2. Statement on condition of substrates and their acceptability for installation of product.
  3. Statement that products at Project site comply with requirements.
  4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  6. Statement whether conditions, products, and installation will affect warranty.
  7. Other required items indicated in individual Specification Sections.
- P. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- Q. Material Safety Data Sheets: Submit information directly to Owner. If submitted to Engineer, Engineer will not review this information but will return it with no action taken.

## **PART 3 - EXECUTION**

### **3.1 CONTRACTOR'S REVIEW**

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

### **3.2 ENGINEER'S ACTION**

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:
1. No Exceptions Noted
  2. Exceptions Noted
  3. Returned For Correction

- C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

**END OF SECTION**

# **DIVISION 2**

## **SITE CONSTRUCTION**

## **SECTION 02232**

### **SITE CLEARING**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Protecting existing trees and vegetation to remain.
  - 2. Removing trees and other vegetation.
  - 3. Clearing and grubbing.
  - 4. Topsoil stripping.
  - 5. Removing above-grade site improvements.
  - 6. Disconnecting, capping or sealing, and abandoning site utilities in place.
  - 7. Disconnecting, capping or sealing, and removing site utilities.
- B. Related Sections include the following:
  - 1. Division 1 Section "Construction and Temporary Facilities" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and environmental protection measures during site operations.
  - 2. Division 2 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.
  - 3. Division 2 Section "Seeding" for finish grading, including placing and preparing topsoil for lawns and planting.

##### **1.3 DEFINITIONS**

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of weeds, roots, and other deleterious materials.

##### **1.4 MATERIALS OWNERSHIP**

- A. Except for materials indicated to be stockpiled or to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from the site.

##### **1.5 SUBMITTALS**

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings according to Division 1 Section "Closeout Procedures."

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, and mechanical conditions.

#### 1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Improvements on Adjoining Property: Work on adjoining properties is not included in the scope of this project.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Notify utility locator service for area where Project is located before site clearing.

### PART 2 - PRODUCTS

#### 2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 2 Section "Earth Work."
  1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
  1. Restore damaged improvements to their original condition, as acceptable to Owner.

#### 3.2 TREE PROTECTION

- A. Limit impact to existing trees and trees not to be removed:
  1. Do not store construction materials, debris, or excavated material within drip lines of trees not to be removed.
  2. Do not permit vehicles or equipment within drip line of remaining trees.

- B. Do not excavate within drip line of trees, unless otherwise indicated.
- C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
  - 1. Cover exposed roots with burlap and water regularly.
  - 2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
  - 3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
  - 4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

### 3.3 UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing when requested by Contractor.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
  - 1. Owner will arrange to shut off indicated utilities when requested by Contractor.
  - 2. Arrange to shut off indicated utilities with utility companies.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Engineer not less than two weeks in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

### 3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
  - 4. Use only hand methods for grubbing within drip line of remaining trees.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding 8-inch (200-mm) loose depth, and compact each layer to a density equal to adjacent original ground.

### 3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water.
  - 1. Do not stockpile topsoil within drip line of remaining trees.
  - 2. Dispose of excess topsoil as specified for waste material disposal.
  - 3. Stockpile surplus topsoil and allow for resspreading deeper topsoil.

### 3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

### 3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

**END OF SECTION**

## **SECTION 02300**

### **EARTHWORK**

#### **PART 1 - GENERAL**

##### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and Special Provisions apply to this Section.

##### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Preparing subgrades for slabs-on-grade and lawns and grasses.
  - 2. Excavating and backfilling for buildings, structures and retaining walls.
- B. Related Sections include the following:
  - 1. Division 2 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
  - 2. Division 2 Section 02221 "Trench Excavation and Backfill for Pipelines & Appurtenant Structures.
  - 3. Divisions 2, 15, and 16 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

##### **1.3 DEFINITIONS**

- A. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- B. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- C. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Section 01275 "Measurement and Payment or Contract provisions for changes in the Work.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- D. Fill: Soil materials used to raise existing grades.
- E. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 1 cubic yard or more in volume that exceed a standard



penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.

- F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### 1.4 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
  - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.
- B. When, in the opinion of the Engineer, the field soil conditions differ from those represented by the material test reports, new samples shall be taken by the Contractor and delivered to the testing agency for classification and laboratory compaction curve testing. All testing shall be based on the appropriate soil test results.

#### 1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

#### 1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
  - 1. Notify Engineer not less than two weeks in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.
  - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

## **PART 2 - PRODUCTS**

### **2.1 SOIL MATERIALS**

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm)] in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
- D. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- E. Structural Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- F. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- G. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 3/4-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
- I. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- K. Fine grained Liner Subgrade: Naturally or artificially graded mixture of soil with 100 percent passing a 1/2 inch sieve and 50 percent passing a No. 200 Sieve.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

### 3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  - 2. If required, install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

### 3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized regardless of the character of surface and subsurface conditions encountered.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. If rock is encountered within excavations, cease work in the area where rock is discovered until a time and materials change order for the extra work can be agreed upon by the Contractor, Owner and Engineer. The work in the affected area will again proceed after a change order is processed, and no shutdown time or associated additional costs will be awarded other than those agreed upon in the change order.

### 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance

of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

### 3.6 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
  - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

### 3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Engineer.
  - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

### 3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.9 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for Record Documents.
  - 3. Testing and inspecting underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing trash and debris.

6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under steps and ramps, use Structural Fill.
3. Under building slabs, use Structural Fill.
4. Under footings and foundations, use Structural Fill.
5. Under and adjacent to retaining walls, use Structural Fill.
6. In utility trenches within 5 feet of any retaining wall or foundation, use Structural Fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm)] in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Where backfill is to extend higher on one side than on the other, as indicated on the Plans, structural floor beams or other means of restraint shall be installed before such backfill is placed. Should any deflection of the foundation wall result from the Contractor's failure to provide adequate bracing, the Contractor shall remove the backfill or embankment to relieve the deflection, properly brace the wall, and replace the backfill at not additional cost to the Owner.

D. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs and steps, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 97 percent.
2. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.

### 3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  1. Provide a smooth transition between adjacent existing grades and new grades.
  2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  1. Lawn or Unpaved Areas: Plus or minus [1 inch (25 mm)]
- C. Grading inside Building and Structure Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

### 3.14 FIELD QUALITY CONTROL

- A. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
  1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 1000 sq. ft. or less of building slab, but in no case fewer than 3 tests.
  2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each [100 feet (30 m)] or less of wall length, but no fewer than 2 tests.
- C. When testing reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

### 3.15 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
  - C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
    1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
- 3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS
- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

**END OF SECTION**

## **SECTION 02511**

### **VERTICAL MULTISTAGE BOOSTER PUMPS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. Furnish and install vertical, non-self-priming, multistage in-line centrifugal booster pumps, equipped with variable frequency drives and other appurtenant structures as specified in the Contract and this section.

##### **1.2 REFERENCES**

- A. The work in this section is subject to the requirements of applicable portions of the following standards:
  - 1. Hydraulic Institute
  - 2. ANSI – American National Standards Institute
  - 3. ASTM – American Society for Testing and Materials
  - 4. IEEE – Institute of Electrical and Electronics Engineers
  - 5. NEMA – National Electrical Manufacturers Association
  - 6. NEC – National Electrical Code
  - 7. ISO – International Standards Organization
  - 8. UL – Underwriters Laboratories, Inc.

##### **1.3 SUBMITTALS**

- A. Submit, in accordance with Section 01300 proposed manufacturers data for the booster pumps including:
  - 1. Dimensional drawings;
  - 2. Material Specifications;
  - 3. Pump Curves;
  - 4. Five (5) operation manuals for the pumps;
  - 5. A training plan for pump operation that outlines the information that will be provided in the required start-up training for the owner's personnel;
  - 6. Warrantee information.

##### **1.1 AFTER THE SALE IN-FIELD MINIMUM REQUIREMENTS**

- A. The pump manufacturer shall directly employ a North American based, full-time, Field Service Group that is regionally disbursed.
  - 1. They shall provide onsite assistance.
  - 2. They shall provide support by telephone and internet.
  - 3. They shall conduct application and installation group training regularly in the field.
- B. Factory laboratories shall furnish no-charge written performance and teardown reports to the Field Service Group and customer to assist them in resolving field issues.



## 1.2 APPLICATION AND INSTALLATION DOCUMENTATION MINIMUM REQUIREMENTS

- A. The pump manufacturer shall create and provide a Pump Owner's Manual for their pumps that clearly provides data required to properly install the pump.
- B. This manual shall be regularly reviewed and updated by the pump manufacturer to ensure the manual remains both correct and current.
- C. This manual shall be available in a published copy for field use and on the manufacturer's internet site.

## PART 2 - PRODUCTS

### 2.1 BOOSTER PUMPS

- A. The booster pumps must be able to supply a design flow of 10gpm with one pump out of operation and a total boosting head of 415 ft.
- B. The water booster pumps shall be certified and listed by UL for conformance to U.S. and Canadian Standards. Systems that have only the sub-assemblies certified and listed by UL for conformance to U.S. and Canadian Standards and/or UR and/or cUR recognized components shall not be considered equivalent.
- C. Electrical Service to the Pumps shall be 230V, Single (1) Phase.
- D. The pumps shall be rated for a maximum pressure of 360 psi.
- E. The booster pumps shall use advanced variable frequency drive and electronic controller technology.
- F. The system shall have 2 identical pumps. Pumps shall be 3-5 HP, Berkeley BVM(I)2-140, Aurora PVM(I)2(3-5HP) or approved equivalent meeting the specified pump curve.
- G. Each pump shall be capable of operating at a design flow of 10 gpm at a boosting head of 415 ft.
- H. The pumps shall be of the in-line vertical multi-stage centrifugal design.
- I. The pump suction/discharge chamber, motor stool, and pump shaft coupling shall be constructed of stainless steel.
- J. The impellers, pump shaft, diffuser chambers, outer discharge sleeve, impeller seal rings, and seal ring retainers shall be constructed of stainless steel.
- K. The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement. The shaft journal and chamber bearings shall be Tungsten Carbide and Ceramic. Pumps shall be equipped with a high temperature mechanical seal assembly with Tungsten Carbide seal faces mounted in stainless steel components.

## 2.2 VARIABLE FREQUENCY DRIVE MOTORS

- A. The motors shall have a NEMA C face and shall operate at a minimal 3500 RPM with a minimum service factor of 1.15. Drive-end motor bearings shall be designed to absorb thrust and shall be adequately sized to ensure long motor life.
- B. The VFD shall be of the PWM (Pulse Width Modulation) design.
- C. Provide a 3% Line Side Reactor for each VFD. The Line Side Reactor shall reduce harmonics back into the electrical distribution system.
- D. The variable frequency drive enclosure shall include a PI controller, dry contact fault output relay contacts along with analog and digital inputs.
- E. The motor shall detect/protect itself against under voltage, excessive temperature, excessive phase shift, and set-point signal fault.
- F. The motor/drive enclosure shall be rated IP55 and 95% relative humidity.
- G. The motor windings shall be class F rated.
- H. Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

## 2.3 WARRANTY

- A. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

## 2.4 TRAINING

- A. The Contractor provide the following operator instruction:
  - 1. Provide the required training at start-up to the Owner's staff.

**END OF SECTION**

## **SECTION 02615**

### **INTERIOR PIPING, VALVES, AND ACCESSORIES**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This section is the installation of all above ground or exposed (interior) piping, valves, and accessories as shown on the Drawings or identified in the Contract Documents. Interior piping must be furnished and installed complete with all fittings, jointing materials, hangers and supports, anchors, and other necessary appurtenances.

##### **1.2 REFERENCES**

AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water  
AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. For Water  
AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings  
AWWA C115 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges  
AWWA C151 Ductile-Iron Pipe  
AWWA C153 Ductile-Iron Pipe Compact Fittings, 3 In. Through 64 In. for Water Service  
ASTM D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120

##### **1.3 SHOP DRAWINGS AND SUBMITTALS**

- A. The piping layouts shown are schematic and not necessarily to scale. Prepare and submit complete layout drawings, details, and specifications covering all interior piping systems, valves, and accessories as indicated on the Drawings and specified herein.

##### **1.4 CONTRACTOR QUALIFICATIONS**

- A. Pipe jointing and installation must be conducted by experienced workmen in conformance with the pipe manufacturer's installation requirements.

#### **PART 2 - MATERIALS**

##### **2.1 GENERAL**

- A. The flanged ends of all valves and fittings shall be compatible with the pipe sizes and materials to which they are to be attached.
- B. All valves and accessories shall be per the pressure classes appropriate for the discharge pressures and as indicated on the plans.
- C. Length Tolerance - Actual lengths of valves, fittings, etc. shall be within 1/16 inch (plus or minus) of the specified or theoretical length. Modifications of the piping and valve layouts drawn and specified necessitated by use of dimensionally different valves than specified shall be made only with the written approval of the Engineer and at no additional cost to the Owner.

## 2.2 PIPE MATERIALS

### A. Ductile Iron Pipe

1. Furnish Class 52 cement-mortar lined ductile iron pipe (DIP), per AWWA C104, C110, C111, C151, and C153 for all interior pipe and fittings above 1½ inches in diameter, unless other material is specifically called for. Assure each pipe length is marked with nominal size, and class rating, and manufacturer's name and code, at a minimum.
2. Pipe Jointing
  - a. Join pipe, pipe fittings, and valves using flanged joints, unless other joining is specifically called out on the drawings. Assure all flanges conform to the requirements of AWWA C115. All bolts, nuts, and washers are to be Cor-Ten steel or stainless steel.
  - b. Assure couplings are designated for use at the rated pressures of the pipe with which they are utilized. Restrain couplings by use of two or more threaded joining rods between the nearest flanges. Provide lugs where required to span the coupling(s).
  - c. For all 1 inch diameter or less taps into DIP, provide pipe with factory made taps. Provide service saddles for taps of a larger diameter.
3. Assure the pipe interior is cement mortar lined meeting AWWA C104 requirements. Assure the outside pipe surface for aboveground or interior applications is factory coated with a high-solids epoxy primer and field coated with a high-solids epoxy finish

### B. STEEL PIPE

1. Standard Weight Pipe: ASTM A53 or A106, standard weight (Schedule 40) Type S, Grade B or Fed Spec WW-P-404 (galvanized)
2. All steel pipes located where pressures will exceed 300, the pipe shall be: Standard Weight Pipe: ASTM A53 or A106, standard weight (Schedule 80) Type S, Grade B or Fed Spec WW-P-404 (galvanized)
3. Fittings: ANSI B16.3 or Fed Spec WW-P- 521, Type II (galvanized) for galvanized pipe or Type I (black) for ungalvanized pipe
4. Unions: Fed Spec WW-U-531, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe
5. Welding: ANSI B16.9
6. Thread Tape: Teflon; John Crane "Thread Tape", Garlock "Plasti- Thread", or Hoke "EZ Seal"
7. Thread Sealant: Thiokol, Urethane, or Teflon

C. PLASTIC

1. Drain Pipe: ASTM D-1785, Schedule 40 PVC unless otherwise noted
2. Fittings: ASTM D-2464 (threaded), Schedule 40 PVC; ASTM D-2467 (solvent-weld), Schedule 40 PVC

2.3 VALVES

A. Gate Valves

1. Four (4-inch) and larger gate valves shall be iron body, resilient seat with non-rising stems having design, construction and pressure rating conforming to AWWA C509. Gate valves shall be supplied with one operating wheel with an arrow indicating "OPEN".

B. Threaded Gate Valves

1. Gate valves ¾" through 3" shall be Class 125, Type 1, bronze with solid wedge, threaded ends, heavy bronze body and have malleable-iron hand wheel. Gate valves shall have screw over bonnet for extra strength at higher operating pressures and a large port opening for maximum flow rate. Valves must conform to the specifications of MSS-SP-80 for low lead requirements.
2. All valves located on pipes with pressures exceeding 300 psi shall be class 350.

C. Ball Valves

1. Unless otherwise indicated or specified, all 2 1/2" shutoff valves shall be ball valves. Two inch and smaller ball valves for water service shall be of bronze or brass construction with two-piece end entry body, bronze or brass ball, teflon or Viton stem seal, reinforced teflon seats and thrust washer, a removable operating lever, and threaded ends. Each ball valve in gauge isolation service shall be furnished with a round handle. Valves shall be rated not less than 500 psi nonshock cold WOG and shall be driptight in both directions. Valves shall be Conbraco Industries "Apollo 70-100 Series", Powell "Fig 4210T", or Stockham "S-216".

D. Air/Vacuum Valves

1. Furnish air/vacuum valves capable of venting large quantities of air through the discharge orifice when the pump starts, closing tightly when liquid enters the valve body, and permitting large quantities of air to reenter through the orifice when the pump stops to prevent a vacuum forming.
2. The main valve parts are a body, cover, baffle, float, and seat. Assure the baffle shields the float from direct impact of air and water to prevent premature float closure. Assure the seat slip fits into the baffle or cover and lock in place without any distortion. Assure the float is stainless steel and center guided, not free floating, for positive seating.

3. Include a water diffuser, shrouding the entire float and baffle assembly, to prevent water from slamming the float shut.
  4. Outlets are to be threaded.
  5. Furnish air/vacuum valves as manufactured by Valve & Primer Corporation (APCO Series 140DAT Air/Vacuum Valve with Water Diffuser) or an approved equivalent.
- E. Pressure Reducing Valves
1. The pressure reducing valves shall be rated for inlet pressures of 300 psi. Outlet pressures shall be adjustable from 40 to 80 psi.
  2. The valve body shall be of cast iron, with flanges conforming to the latest ANSI Standards. The valve shall be extra heavy construction throughout. The valve interior trim shall be bronze B-62 as well as the main valve operation.
  3. The valve seals shall be easily renewable while no diaphragm shall be permitted within the main valve body. A visual valve position indicator shall be provided for observing the valve piston position at any time.
- F. Swing Check Valves
1. Furnish swing check valves with ductile iron bodies and a Buna-N disc having an O-ring seating edge and internal steel reinforcements.
  2. Assure the flow area through the valve body is equal to or greater than the nominal pipe diameter at all points through the valve. Valve shall be capable of passing a 3 inch sphere.
  3. Assure the disc is on a 45 degree angle to minimize distance of travel from the closed to full open position and replaceable in the field for ease of maintenance.
  4. Furnish swing check valves as manufactured by Val-Matic (Swing-Flex Check Valve), Valve & Primer Corporation (APCO Series 100 Rubber Flapper Swing Check Valve), or an approved equivalent.
- G. Pressure Relief Valves
1. The pressure valves per the appropriate pressures and sizes indicated on the plans
  2. The pressure reducing valve as manufactured by Cla-Val or approved equivalent.
  3. Valves to be direct acting spring loaded diaphragm type unless otherwise indicated on the plans.

## 2.4 METERS

### A. Magnetic Flow Meter (Magmeter)

1. The flowmeter shall measure the flow of water in the discharge pipe and transmit a flow signal to the meter mounted amplifier. Flow meter electronics shall be meter mounted.
2. The meter shall be magnetic flow meter, utilize DC pulsed excitation and shall automatically re-zero after every cycle. The meter shall produce a signal output that is directly proportional and linear with the volumetric flow rate of the flowing liquid. External ultrasonic electrode cleaners shall not be acceptable.
3. The magnetic flow meter shall be flanged.
4. The flow sensors shall be constructed of ductile iron with a polyurethane liner. The sensor's internal components are to be completely encapsulated in the polyurethane lining material, to provide maximum protection from moisture.
5. The accuracy shall be a minimum  $\pm 2\%$  at all flow rates above 1 fps. Accuracy shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.
6. The electronic transmitters shall be sensor mounted enclosed in a NEMA-4X housing and provide a standard isolated 4-20 ma dc analog output proportional to the flow through the meter. The flow meter power supply shall be 85-265 VAC, 45/65 Hz. Power consumption shall not exceed 24 Watts.
7. Furnish magmeters as manufactured by Sparling Instruments Co. (Model 621), Badger Meter, Inc. (Magnetoflow Mag Meter), or an approved equivalent.

## 2.5 COUPLINGS

- A. Provide extended range couplings with rings constructed of ductile iron conforming to ASTM A536 and gaskets suitable for use with potable water.
- B. Install couplings as shown on the plans.
- C. Furnish couplings as manufactured by Romac Industries (Style XR 501) or approved equivalent.

## 2.6 PRESSURE GAUGES

- A. Furnish 4 ½ inch (115 mm), oil-filled pressure gauges with grade B accuracy, rated for use with water. Assure gages are hermetically sealed with case constructed of stainless steel, aluminum, polypropylene, or phenolic plastic and have a white background, black enameled pointer with a 270 degree arc, and a clear acrylic window.
- B. Provide pressure gages with a gauge range of 0 to 350 pounds per square inch unless otherwise indicated on the Drawings.

- C. Provide gages with ½ inch fittings prepared in pipe for acceptance of gage. Provide ½ inch (13 mm), brass or bronze shut-off cocks conforming to ASTM B16 or B62 or a ball valve on the connection between pipe and gage. If ball valve is used, provide sufficient stem extension for ease of full operation of handle.
- D. Provide gages with solid front with side or rear blowout relief.
- E. Furnish pressure gages as manufactured by Ashcroft, Crosby, Marsh, or an approved equivalent.

## 2.7 MISCELLANEOUS

### A. Floor Drains

- 1. Furnish slotted floor drain covers with a satin bronze top of the sizes shown on the Drawings.
- 2. Furnish Schedule 40 PVC pipe, solvent-welded for drain pipes. Assure a PVC trap is included with each floor drain.

### B. Adjustable Pipe Supports

- 1. Where specified in the Drawings, provide adjustable steel pipe supports complete with saddle, stanchion, and base plate sized as per manufacturer's recommendations.
- 2. Furnish pipe supports as manufactured by Anvil (Fig. 258, Pipe Saddle Supports) or approved equivalent.

### C. Sampling Taps

- 1. Furnish smooth-nosed sampling taps without interior or exterior threads, for bacteriological analysis where indicated.
- 2. Sampling taps may not be of the petcock type or mixing type and may not have a screen, aerator, or other such appurtenance.

### D. Hose Bibs

- 1. Furnish brass hose bibs that are angled to allow hose to be inserted and extended away from the hose bib without creating a bend in the hose.
- 2. Assure each hose bib is supplied with an atmospheric vacuum breaker.

### E. Well/Surge Tank

- 1. Tanks to be diaphragm/bladder type and pre-pressurized Amtrol Well-X-Trol Model WX44C or approved equivalent.
- 2. The tank shall be welded steel and tested in accordance to ASME codes. Working pressure to be a minimum of 175 psi.

## PART 3 - EXECUTION



### 3.1 GENERAL

- A. Install all pipes to standards set forth in MPWSS, industry standards, and in strict accordance with manufacturer's recommendations.

### 3.2 PIPING

#### A. Handling

1. Handle pipe, fittings, and accessories in a manner that will ensure installation in sound, undamaged condition. Assure equipment, tools, and methods used in handling and installing pipe and fittings do not damage the pipe and fittings. Any hooks inserted in ends of pipe must have broad, well padded contact surfaces.
2. Replace pipe and fittings with cement lining that has been damaged. Small and readily accessible damaged areas may be repaired.
3. Repair all pipe coating(s) that have been damaged before installing the pipe.

#### B. Cutting Pipe

1. Cut pipe in a neat manner, without damaging the pipe or the lining. Assure cuts are smooth, straight, and at right angles to the pipe axis. After cutting, dress the end of the pipe with a file to remove all roughness and sharp corners.
2. Cut cast iron pipe with mechanical pipe cutters except where the use of mechanical cutters would be difficult or impractical.
3. Field cut holes for saddles with mechanical cutters. Oxyacetylene cutting will not be permitted.
4. Repair chipped, spalled, or otherwise damaged linings.

#### C. Cleaning

1. Thoroughly clean the interior of all pipe and fittings of foreign matter before installing and keep clean until the work has been accepted.
2. Before jointing, wipe clean all joint contact surfaces and kept clean until jointing is completed.
3. Take precautions to prevent foreign material from entering the pipe during installation. Do not place debris, tools, clothing, or other materials in or allow to enter the pipe.

#### D. Pipe Jointing

1. Threaded Pipe

- a. Assure threaded pipe threads conform to ANSI B2.1, NPT and are full and cleanly cut with sharp dies. Ream ends of pipe, after threading and before assembly, to remove all burrs.
  - b. Make up threaded joints with thread tape applied to all make threads or a suitable joint sealant. For all lines subject to vacuum, joint sealant will be required, and thread tape will not be allowed.
  - c. Not more than three threads at each pipe connection may remain exposed after installation.
2. Solvent Welded
- a. Cut the ends of PVC pipe square and smooth and wipe clean.
  - b. Apply solvent cement to the outside of the pipe and the inside of the fitting socket with a small paint brush. Immediately push the coated surfaces snugly together and rotate the pipe approximately one-half turn to insure uniform distribution of the cement. Remove excess cement by wiping.
3. Push-On Joints
- a. Follow the pipe manufacturer's instructions and recommendations for proper jointing operations.
  - b. Suitably bevel each spigot end to facilitate assembly.
  - c. Lubricate all joint surfaces with heavy vegetable soap solution immediately before the joint is completed. Assure lubricants are suitable for use in potable water. Store lubricants in closed containers and keep clean.
4. Flanged Joints
- a. Assure that the pipe extends completely through screwed on flanges and that the flange faces are flat and perpendicular to the pipe centerline. Assure that the pipe end and flange faces are finish machined in a single operation.
  - b. When bolting flanged joints, take care to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange must be free to move in any direction while the flange bolts are being tightened. Gradually tighten bolts at a uniform rate, so gasket compression is uniform.
  - c. Take special care when connecting to equipment to insure that no stresses are transmitted to the flanges by the connected piping. Permanently support all such piping, so accurate matching of bolt holes and uniform contact over the entire surface of abutting piping flanges are obtained before installation

of any bolts in those flanges. In addition, assure connection piping is free to move parallel to its longitudinal centerline while the bolts are tightened.

- d. Movable flanges ("Kwik-Flanges") may be used in lieu of welded or threaded flanges in areas where their use will not interfere with pipe support or valve, fitting, or appurtenance mounting, provided they are of comparable pressure rating and are installed in complete accordance with the manufacturer's specifications.

## 5. Mechanical Joints

- a. Mechanical joints are shown on the Drawings or specified at various locations on pipe and fittings to aid in assembly and/or allow flexibility. Changes in the locations of such joint or the use of mechanical couplings in lieu of mechanical joint fittings will be allowed if functionally equivalent only with the approval of the Engineer. Such changes or substitutions must be fully indicated on the submittals.
- b. Carefully assemble mechanical joints in accordance with the manufacturer's recommendations. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint. Overtightening bolts to compensate for poor installation practice will not be permitted.
- c. Anchor all exposed piping with mechanical joints or couplings with tie rods.

Carefully align the holes in mechanical joints with tie rods to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top (or side for vertical piping) centerline. Assure the top (or side) centerline on each flange and mechanical joint piece is marked at the foundry.

## 6. Flanged Coupling Adapters

- a. Install flanged coupling adapters in accordance with the coupling manufacturer's recommendations
- b. After the pipe is in place and bolted tight, determine the proper locations of holes for the anchor studs and field drill the pipe. Assure hole diameter are not more than 1/8 inch larger than the diameter of the stud projection.

## 7. Mechanical Couplings

- a. Carefully install mechanical couplings in accordance with the manufacturer's recommendations.
- b. Clean and smooth pipe ends before installation.
- c. Leave a space of at least 1/4 inch and not more than 1 inch between the pipe ends.

E. Finishing

1. After all piping has been tested and approved, thoroughly clean all pipe surfaces and paint all pipe, fittings, and supports designated to receive paint.

3.3 VALVES, EQUIPMENT, AND ACCESSORIES

A. Installation

1. Install all valves, equipment, and accessories in accordance with the manufacturer's requirements. Reference shall be made to jointing and alignment specifications.

B. Testing

1. Pressure test all valves in a similar manner to and in conjunction with the testing prescribed for piping systems.
2. Additionally, individually test each valve for full and unhindered operation after installation.

C. Finishing

1. Furnish valves, equipment, and accessories of metallic construction with the manufacturer's standard shop finish. Upon installation, paint with the same type and color of paint as the piping on which they are installed.
2. Take care to insure compatibility of the field-applied coatings with the manufacturer's shop coat. Use tie or binder coats, as required.
3. Paint operating handwheels, nuts, and tee-handles red or black, per the Owner's preference.

**END OF SECTION**

## SECTION 02665

### HDPE PIPING

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. Furnish and install high density polyethylene (HDPE) pipe and fittings including manholes, service lines, and other appurtenant structures as specified in the Contract and this section. Pipe strength classifications are specified on the plans, listed in the Contract Documents, or specified herein.

##### 1.2 REFERENCES

ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM D3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3350	Polyethylene Plastic Pipe and Fittings Material
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, ½ In. Through 3 In.
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings , 4 In. Through 63 In.

##### 1.3 STANDARD DRAWINGS

- A. Standard Drawing No. 02660-2: Water and Sewer Main Separation

##### 1.4 CONTRACTOR QUALIFICATIONS

- A. HDPE pipe thermal fusion welding and installation must be done by a firm or individual(s) having demonstrated satisfactory certification and performance history in the installation of HDPE pipe. If subcontracted, the firm or individual(s) will be responsible to the Contractor for all phases of HDPE pipe installation.
- B. Submit the following information within 5 calendar days of the Bid Opening.
  - 1. Copies of current factory certification(s) for the Contractor, or proposed Subcontractor, for the installation and thermal fusion welding of HDPE pipe in accordance with Code of Federal Regulations (CFR) Title 49 and Part 192.285.
  - 2. A list of similar work completed by the Contractor, or proposed Subcontractor, within the last 2 years that totals the installation of at least 1 mile (1.6 km) of 4 inch (100 mm) diameter or greater HDPE pipe using thermal fusion welded joints.
- C. Failure by a prospective Bidder to submit the required information within the allotted time will be deemed a material irregularity, which may result in the bid being determined non-responsive and rejected.
- D. The information provided will be evaluated by the Owner and Engineer to determine if the experience and qualifications submitted are adequate to perform the work. The Owner and Engineer's interpretation of Contractor or Subcontractor's ability to perform the work will be final.

- E. The information may be submitted to the Engineer up to 10 days before the bid opening for prequalification.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Furnish all HDPE piping as specified in the Contract Documents and meeting the materials and testing requirements of this Section. Furnish all fittings of the same material and design as the specified piping. Furnish the pipe sizes and strength classifications shown in the Contract documents.
- B. References to ASTM, or AASHTO designation, means the latest revision at the time of call for bids.
- C. Assure all pipe is clearly marked with type, class and/or thickness as applicable. Assure lettering is legible and permanent under normal handling and storage conditions.
- D. Furnish a manufacturer's certification for all pipe and fittings, certifying that the pipe and fittings meet the contract requirements.

### **2.2 HIGH DENSITY POLYETHYLENE PIPE (HDPE)**

- A. Furnish HDPE pipe meeting AWWA C901 or C906 and ASTM D3350, with a material designation code of PE 3408, a cell classification of PE 34-5434C, and a DR of 11.
- B. Assure HDPE pipe is manufactured with an ultraviolet (UV) stabilizer.
- C. Furnish pipe with iron pipe size (IPS) outside diameters. Assure dimensions and workmanship meet ASTM F714 requirements for nominal diameters of 4 inches (100 mm) or greater and ASTM D3035 for nominal diameters smaller than 4 inches (100 mm).
- D. Assure all HDPE pipe used in potable water applications is NSF approved.

### **2.3 FITTINGS**

- A. Use tee or wye fittings for connecting service lines of the same material, construction, and joint design as the main pipe.
- B. Furnish special fittings meeting the Contract Documents.

### **2.4 PIPE JOINTING**

- A. Thermally fuse HDPE pipe and fittings by one of the following types of thermal fusion per the manufacturer's recommended procedures: butt fusion, saddle fusion, or socket fusion.
- B. Thoroughly clean all pipe segments prior to fusing to assure no HDPE pieces remain in the pipe (these pieces may clog air valves).
- C. HDPE pipe and fittings may be joined together through the use of electrofusion fittings with the Engineer's approval.

- D. Join HDPE pipe and fittings to other materials with flange adapters with back-up rings, mechanical couplings designed for connecting HDPE pipe and fittings to another material, or mechanical joint adapters. Consult the manufacturer of the joining device for proper installation procedures.

## **PART 3 - EXECUTION**

### **3.1 PIPE LINE INSTALLATION**

- A. Excavation and Backfill
  - 1. Excavate and backfill pipelines meeting the applicable portions of SECTION 02221: TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES.
- B. Responsibility for Materials
  - 1. The Contractor is responsible for all material furnished. Replace all material found defective in manufacture or damaged in handling after delivery. This includes furnishing all material and labor required for the replacement of installed material discovered defective before final acceptance of the work or during the guarantee period.
  - 2. The Contractor is responsible for the safe storage of material intended for the work until it has been incorporated in the completed project.
- C. Handling of Pipe
  - 1. Deliver and distribute all pipe to the site. Load and unload pipe, fittings and accessories by lifting with hoists or skidding to avoid shock or damage. Do not drop any materials. Do not roll or skid pipe handled on skidways against pipe already on the ground.
  - 2. In distributing the material at the site of the work, unload each piece opposite or near the place where it is to be laid in the trench. Keep the interior of all pipe and other accessories free from dirt and foreign matter at all times.
  - 3. Repair or replace all damaged pipe at Contractor's expense on the jobsite.
- D. Laying Pipe
  - 1. Lay and maintain all pipe to the specified lines and grades with fittings at the specified locations.
  - 2. Use tools and equipment, satisfactory to the Engineer, for the safe and convenient prosecution of the work. Carefully lower all pipe and fittings into the trench to prevent damage to the pipe materials and protective coatings and linings. Do not drop or dump any materials into the trench.
  - 3. Take every precaution to prevent foreign material from entering the pipe while it is being installed. At times when pipe laying is not in progress, close the open ends of the pipe using a plug or other means approved by the Engineer. Clean and remove all sand, gravel, concrete and cement grout that has entered the lines during construction.
  - 4. Place pipe bedding in the bottom of the trench meeting Section 02221; TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES. Voids may be left in the bedding material to remove pipe slings to allow support along the full length of the pipe barrel.
  - 5. Join sections of HDPE into continuous lengths above ground. Assure the equipment used to join pipe sections shall be capable of meeting all conditions

recommended by the pipe manufacturer, including but not limited to, temperature requirements of a minimum of 400 degrees Fahrenheit (204° C), alignments, and an interfacial fusion minimum pressure of 75 pounds per square inch (517 kPa).

6. Cut pipe for inserting fittings in a neat and workmanlike manner without damaging the pipe or coating and leaving a smooth end at right angles to the pipe axis. Do not cut pipe using an oxyacetylene torch.

E. Tolerances

1. Install the pipe within ½ inch (13 mm) of the specified alignment and within ¼ inch (6 mm) of the specified grade.

### 3.2 Thermal Fusing HDPE

A. Butt Fusion

1. Clean pipe ends thoroughly with cotton cloth. Assure no HDPE cuttings remain in the pipe. Face the pipe ends to establish clean, parallel mating surfaces. Continue facing until a minimal distance exists between the fixed and movable jaws of the machine and the facer is locked firmly and squarely between the jaws. Provide a perfectly square face, perpendicular to the pipe centerline on each pipe end and with no detectable gap.
2. Align and round the pipe profiles with each other to minimize mismatch (high-low) of the pipe walls. Clamping jaws must not be loosened during fusion. Clamp the pipe as close to the joint area as possible to ensure proper pipe alignment.
3. Use heating tool with internal thermometer, assuring heater faces are clean, oil-free, and coated with a nonstick coating as recommended by the manufacturer. Periodically verify the proper surface temperature using a pyrometer or surface temperature measuring device. Melt the pipe interfaces until the proper bead size is formed per manufacturer's recommended temperature and bead size, without applying pressure.
4. Join the pipe ends rapidly, but carefully, with sufficient pressure to mix the pipe materials and form a homogenous joint. Follow manufacturer's recommendations for internal pressure or bead size of molten material.
5. Hold molten joint immobile under pressure as indicated until cooled adequately to develop strength. Use cooling times established by the pipe manufacturer. Do not apply water, wet cloths, or similar to shorten cool time.
6. Each fused joint must have a complete double roll-back bead and be inspected by Contractor personnel with qualifications approved under Section 02665.1.5.

B. Saddle/Sidewall Fusion

1. Remove any dirt or coating that might interfere with the proper installation of the fusion machine.
2. Install the proper size heater saddle adaptors on the heater plate. Do not over tighten, but insure that mating surfaces of the heater and adapters are clean and flush. Heat the plates to the temperature specified by the pipe and fitting manufacturer.
3. Install the saddle fusion machine to the pipe using appropriate tooling and the manufacturer's instructions to straighten and round the pipe. Do not flatten pipe when tightening clamping fixture.
4. Clean and roughen pipe surface and fitting saddle contour with 50 or 60 grit utility cloth to expose fresh material. Brush away residue with a clean, dry cloth



after roughening the surfaces. Do not use sandpaper or other abrasive materials that are likely to leave grit or deposits of other foreign materials on the pipe surface.

5. Position the fitting on the pipe and place the fitting into the saddle-fitting holding insert. Apply a slight downward force on the fitting and inspect to insure a precise fit to the pipe. Move the fitting away from the pipe, then back to the pipe and inspect again for precise alignment.
6. Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or surface temperature measuring device. Place the heater tool in position to heat the pipe and fitting surfaces in accordance with the pipe and fitting manufacturers' instructions.
7. Join the pipe and fitting surfaces with sufficient pressure to mix the pipe materials and form a homogenous joint. Follow manufacturer's recommendations for pressure or bead size of molten material.
8. Hold molten joint immobile under pressure as indicated in g above until cooled adequately to develop strength. Cooling times shall be established by the pipe manufacturer. Do not subject the joint to any external stresses or apply water, wet cloths, or similar to shorten cool time.
9. Each joint must be inspected by Contractor personnel with qualifications approved under Section 02665.1.5.

### 3.3 JOINING HDPE TO OTHER PIPE MATERIALS

#### A. Flanged Connections for HDPE Pipe

1. Assure all flange connections made with HDPE pipe include the placement of metal backing as recommended by the HDPE manufacturer.
2. Butt fuse the flange adapter or stub end to the plastic pipe segment. Position the flange face of the adaptor as required so that the back-up ring on the plastic pipe segment can be attached to the metal flange.
3. Snug flanges to be joined prior to bolting. Adjust pipe spool position as required to assure snug fitting prior to bolting. Install and tighten flange bolts in alternating pattern, drawing the metal and plastic flange faces evenly and flat. Do not use the flanges to draw the two pipe sections together.

#### B. Mechanical Compression Joints for HDPE Pipe

1. Provide mechanical joints only where specifically called for on the Drawings. Provide mechanical joints consisting of, at a minimum, a threaded compression nut or a follower and bolt arrangement, an elastomer seal ring, and a stiffener.
2. Insert pipe stiffeners to provide support under the seal ring and gripping ring. Assure stiffener is long enough to prevent collapse of the pipe.
3. Compress the seals by tightening the threaded compression nuts or follower and bolt arrangements. Assure seals are pressure-tight.
4. Each joint must be inspected by Contractor personnel with qualifications approved under Section 02665.1.5.

### 3.4 TESTS

#### A. Hydrostatic and Leakage Testing for Transmission Mains

1. Perform hydrostatic and leakage testing in accordance with AWWA C600 for all force mains. Once the pipe is laid and backfilled, test for at least 2 hours, all newly laid pipe, or any valved section, at the highest point along the test section.

The maximum length of pipe to be tested at one time shall be 3,000 linear feet unless otherwise approved by the Engineer. Test to a hydrostatic pressure equal to the pressure rating of the pipe at the test point, but in no case less than a minimum gage pressure of 100 pounds per square inch (931 kPa) or greater than a maximum gage pressure of 200 pounds per square inch (1,379 kPa).

2. Slowly fill the pipe with water, purging all air, and apply the test pressure using a pump hooked up so that the pressure and leakage can be measured. To purge the pipe of air during the test, it is necessary to tap the pipe at its highest points if permanent air vents are not located at the high points. Use corporation stops for this purpose. Furnish the pump connections, gauges, stops, and all necessary apparatus for testing.
3. Disassemble and reassemble all joints showing leakage after thorough cleaning. Remove and replace all cracked or defective pipes or fittings discovered during the pressure test with sound material and repeat the test.
4. Conduct the leakage test concurrent with the pressure test for 2 hours. Leakage is defined as the quantity of water supplied into the pipe, or any valved section thereof, necessary to maintain pressure within 5 pounds per square inch of the pressure test after the pipe has been filled with water and purged of air.
5. The pipe installation will be rejected if the leakage exceeds that determined by the following formula:
$$L = SD(P)^{1/2} \div 133,200$$
In which L equals the allowable leakage in gallons per hour; S is the length of pipe being tested, in feet; D is the nominal diameter of the pipe being tested, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.
6. Where the pipe being tested for leakage is thermally fused HDPE, the allowable leakage will be reduced to 25% of L, as calculated.
7. Should any test of pipe laid disclose leakage exceeding that specified above, locate and repair the defective joints until the leakage is within the specified allowance.
8. Conduct the pressure and leakage tests with the Engineer present.

B. Cleaning, Disinfection, and Testing Water Mains

1. Clean, disinfect, and test HDPE used in potable water mains in accordance with Paragraphs 3.1.B through 3.1.D, as modified, in Section 02660: WATER DISTRIBUTION.

3.5 WATER AND SEWER MAIN SEPARATION

- A. Assure horizontal and vertical separation between water mains and sewer mains meeting the details on Standard Drawing No. 02660-2.

3.6 WATER MAIN INSULATION

- A. When crossing under, over, or within six feet of culverts that are open to the air, or in cases where less than six feet of cover is provided, provide insulation on new water mains the full width of the trench excavation.
- B. Furnish 2 inch thick Styrofoam HI brand plastic foam insulation (Blue Board) with tongue and groove joints or an approved equivalent. Friction fit the joints and secure with an adhesive according to the manufacturer's recommendations.

- C. Place a 6 mil polyethylene sheeting over the insulation, lapping any joints a minimum of 12 inches.
- D. Place a 6 inch sand cushion above and below the insulation.

**PART 4 - MEASUREMENT AND PAYMENT**

See Section 01275: MEASUREMENT AND PAYMENT.

**END OF SECTION**

# **DIVISION 3**

## **CONCRETE**

## **SECTION 03600**

### **GROUT**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This section covers the grouting of structural base plates, equipment baseplates and other miscellaneous uses of non-shrinking grout as indicated on the Drawings. This section also covers epoxy grouting of anchor bolts and reinforcing bars to be installed in hardened concrete.

##### **1.2 RELATED WORK**

03300 Cast-in-place Concrete  
05500 Metal Fabrications & Miscellaneous Metal (Anchor Bolts)

##### **1.3 SHOP DRAWINGS AND SUBMITTALS**

- A. The Contractor shall submit manufacturers' information indicating the application, formulation, and installation procedures for each brand and type of grout to be used in accordance with the General Requirements.

##### **1.4 PRODUCT HANDLING**

- A. Delivery of Materials. The Contractor shall deliver all materials to the job site in original, new and unopened containers bearing the manufacturer's name and label showing at least the following information:
  - (1) Name or title of the material;
  - (2) Fed. Spec. number, if applicable;
  - (3) Manufacturer's stock number;
  - (4) Manufacturer's name;
  - (5) Contents by volume for major constituents;
  - (6) Handling instructions; and
  - (7) Application instructions.
- B. Storage of Materials. The Contractor shall provide proper storage to prevent moisture contamination of, damage to, and deterioration of, grout materials.
- C. Protection. The Contractor shall use all means necessary to protect the materials in this section before, during and after installation and to protect the work and materials of all other trades.

#### **PART 2 - MATERIALS**

##### **2.1 NONSHRINKING GROUT**

- A. Set "Non-Shrink Grout", US Grout, "Five Star Grout", or equal

## 2.2 EPOXY GROUT

Adhesive Two-component liquid equal to Thermal-Chem "Mortar Resin Products No. 3", Minwax "Por-Rok Epoxy Grout"

Aggregate As recommended by the epoxy grout manufacturer

## 2.3 WATER

Clean and free from deleterious substances

# PART 3 - EXECUTION

## 3.1 NONSHRINKING GROUT

- A. General. Nonshrinking grout shall be furnished factory- premixed so only water is added at the jobsite. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.
- B. Preparation. The concrete foundation to receive nonshrinking grout shall be saturated with water for 24 hours prior to grouting.
- C. Placement. Grout shall be placed in strict accordance with the directions of the manufacturer so all spaces and cavities below the top baseplates or against concrete slabs or walls are completely filled without voids. Forms shall be provided where structural components of baseplates or launders will not confine the grout.
- D. Finishing. The grout shall be finished smooth in all locations where the top surface or edge of the grout will be exposed to view after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.
- E. Curing. Nonshrink grout shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. After edge finishing is completed, the grout shall be wet-cured for at least seven days.

## 3.2 EPOXY GROUT

- A. General. Components shall be packed separately at the factory and field mixed. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.
- B. Preparation. Where indicated on the Drawings, anchor bolts and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be 1/4-inch larger than the maximum dimension of the bolt head, and 1/2-inch larger than the bar diameter. The embedment depth for epoxy-grouted anchor bolts and reinforcing bars shall not be less than ten bolt or bar diameters unless indicated otherwise on the Drawings.
- C. Holes shall be prepared for grouting as recommended by the grout manufacturer.

- D. Installation. Anchor bolts and reinforcing bars shall be clean, dry, and free of grease and other foreign matter at the time of installation. The bolts and bars shall be set and positioned and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to insure that all spaces and cavities are filled with epoxy grout, without voids.

**END OF SECTION**

# **DIVISION 11**

## **EQUIPMENT**



## **SERIES 11210**

### **SUBMERSIBLE TURBINE PUMPS**

#### **PART 1 - GENERAL**

##### **1.1 MANUFACTURER REQUIREMENTS**

- A. Manufacturer shall be in active production of Vertical Submersible Turbines used on submersible water well motors.
- B. Each factory assembled pump shall be wet tested at 3 points to verify it meets factory specifications and the resulting curve from this test shall be shipped with the pump.
- C. Curves used to select the pump must have their accuracy verified by the pump manufacturer as true and correct for current production. A curve and manufacturer statement confirming this shall be submitted with the bid.
- D. Manufacturer shall be a recognized member of water systems industry associations such as National Groundwater Association (NGWA) and Water Systems Council (WSC) and actively contribute both human and financial resources to continuously improving water industry standards.
- E. Pumps and motors shall be by the same manufacturer to ensure the best optimization of components relative to performance and service life.

##### **1.2 QUALITY REQUIREMENTS**

- A. Pumps shall be produced in an ISO certified facility in North America.
- B. Every factory assembled pump shall be wet tested to verify it meets manufacturing performance specifications prior to shipment.

##### **1.3 SUBMITTALS**

- A. Submit, in accordance with Section 01300 proposed manufacturers data for the booster pumps including:
  - 1. Dimensional drawings;
  - 2. Material Specifications;
  - 3. Pump Curves;
  - 4. Five (5) operation manuals for the pump systems;
  - 5. A training plan that outlines the information that will be provided in the required start-up training for the owner's personnel;
  - 6. Warrantee information.

#### 1.4 PERMANENTLY AFFIXED NAMEPLATE MINIMUM DATA

- A. Original Manufacturer's Name (OEM)
- B. Country of Assembly
- C. Model Number (pump description)
- D. Serial Number (a unique manufacturing number for this unit)
- E. Order Number (bill of material number)
- F. Pump Submersible Motor hp Required

#### 1.5 AFTER THE SALE IN-FIELD MINIMUM REQUIREMENTS

- A. The pump manufacturer shall directly employ a North American based, full-time, Field Service Group that is regionally disbursed.
  - 1. They shall provide at-the-well site assistance.
  - 2. They shall provide support by telephone and internet.
  - 3. They shall conduct application and installation group training regularly in the field.
- B. Their group shall maintain factory based training facilities in North America and schedule periodic training classes.
- C. Factory laboratories shall furnish no-charge written performance and teardown reports to the Field Service Group and customer to assist them in resolving field issues.

#### 1.6 APPLICATION AND INSTALLATION DOCUMENTATION MINIMUM REQUIREMENTS

- A. The pump manufacturer shall create and provide a Pump Owner's Manual for their submersible pumps that clearly provides data required to properly install the pump.
- B. This manual shall be regularly reviewed and updated by the pump manufacturer to ensure the manual remains both correct and current.
- C. This manual shall be available in a published copy for field use and on the manufacturer's internet site.

### **PART 2 - MATERIALS**

#### 2.1 SUBMERSIBLE TURBINE PUMP

- A. The assembled submersible turbine pumps shall be Berkeley Model No. B10P4MS15231 or approved equivalent. The pumps must be able to supply a design flow of 10gpm with one pump out of operation and a total head of 346.5 ft.

- B. The water booster pumps shall be certified and listed by UL for conformance to U.S. and Canadian Standards. Systems that have only the sub-assemblies certified and listed by UL for conformance to U.S. and Canadian Standards and/or UR and/or cUR recognized components shall not be considered equivalent.
- C. Electrical Service to the Pumps shall be 230V, Single (1) Phase, 3-Wire

## 2.2 PUMP CONSTRUCTION

- A. Motor Adapter, Bowls, and Discharge Case Materials shall be stainless steel. They shall be free from sand holes, blow holes or other faults and must be accurately machined and fitted to close tolerances.
- B. Upthrust Protection .The top end of the pump shall have an upthrust protection system that includes an ASTM A320 type 300 series stainless steel bolt that accurately allows for the adjustment of the upthrust gap.
- C. Impellers shall be enclosed type and investment cast from ASTM A743 CF8 type 316 series stainless steel or acetal. They shall be free from defects and must be balanced to a tolerance of 0.014 oz-in (single plane) for optimum performance and minimum vibration. Impellers are to be standard product of the pump manufacturer and not contain special workmanship to temporarily increase efficiency.
- D. Impeller Fastening. The impellers shall be secured to the shaft with taper locking collets of ASTM A276 type 416 series stainless steel.
- E. Suction Inlet Adapter/Bracket shall stainless steel. The inlet area shall have a net open area of at least four times the eye of the impeller.
- F. Suction Inlet Bearing Protection. This bearing shall be protected from abrasive damage by an inlet bracket designed that only allows pumped water to enter above the bearing. The bearing shall also be protected by a sand rejection collar placed just above the bearing. The sand rejection collar shall be made of ASTM A276 type 300 series stainless steel.
- G. Suction Inlet Strainer/Screen shall only allow water to enter above the bearing. The strainer/screen shall be made of ASTM A666 type 300 series stainless steel.
- H. Stable Performance Components. Impellers shall be acetal or 300 grade stainless steel. The synergy of these two hard and durable materials to resist wear shall provide superior first set pump characteristic performance over its operating life relative to wear ring designs.

- I. Pump Shaft shall be 300 grade stainless steel. The shaft shall be precision turned, ground and polished to a minimum surface finish of 40 rms (root mean squared).
- J. Case, Bowls and Adapter Connections shall be of the high pressure bolt together style. The bolts shall be quick drive hex head type 300 series stainless steel.
- K. Cable Guard shall be ASTM A666 type 300 series stainless steel and be positively attached to the pump with 300 series stainless steel, slotted, hex head screws. The screw head shall be suitable for either a socket or a straight blade screwdriver.
- L. Motor Coupling shall be stainless steel and shall conform to NEMA specifications. The coupling shall be capable of transferring the total torque including starting torque in either direction of rotation. The coupling shall have a set screw so it can be correctly positioned on the pump shaft.
- M. Pump Discharge Threading shall be FNPT (Female National Pipe Tapered) threads.
  - 1. 4-inch pumps shall have 1 1/4"-inch FNPT threads.
- N. Column Pipe shall be "Grade A" steel pipe with the ends machined with 8 threads per inch with 3/4-inch taper. Inside diameter of the pipe shall have losses equal to or less than 5-feet per 100- feet of length. Pipe shall be connected with threaded sleeve steel couplings and threaded spring loaded check valves as required by the motor manufacturer application manual.
- O. Pump control shall include a protection system for detection of overload, underload, overheating, and rapid cycling and shall include a lightning arrestor.

## 2.2 INDUSTRY STANDARD REQUIREMENTS

- A. Pumps shall be designed and furnished in accordance with the HI (Hydraulic Institute) and AWWA (American Water Works Association) specifications for submersible turbine pumps.

## 2.3 DESIGN CONDITIONS

Design flow requirements:	<u>10</u> gpm (gallons per minute)
Design total dynamic head: _	<u>346.5</u> feet (TDH)
Liquid to be pumped:	<u>Water</u>
Casing inside diameter: _	<u>6</u> inches

**END OF SECTION**

## SECTION 11240

### CHLORINATION EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. This work is furnishing and installing chlorination equipment of the sizes and types indicated on the Contract Drawings for the application of liquid sodium hypochlorite (NaOCl).

##### 1.2 REFERENCES

- A. The current publications listed below form a part of this specification.

AWWA B300  
CFR

Hypochlorites  
Code of Federal Regulations.

##### 1.3 SUBMITTALS

- A. Submit, in accordance with Section 01300 proposed manufacturers data for the booster pumps including:
  - 1. Dimensional drawings;
  - 2. Material Specifications;
  - 3. Five (5) operation manuals for the pump systems;
  - 4. Warrantee Informatin.

#### PART 2 - PRODUCTS

##### 2.1 METERING PUMPS

- A. Furnish and install one metering pump and provide a second identical pump to the Owner as a back-up replacement.
- B. Assure the pumps are manually, externally adjustable from 5% to 100% of the maximum feed rate. Assure all wetted parts of the pump and fittings have been approved for potable water applications.
- C. Assure pumps are rated for 140 psi minimum working pressure.
- C. Provide pumps sized for a 120 V, 60 Hz service.
- E. Pump shall be adjustable with a maximum flow rate of at least 0.1 gallons per hour and a minimum flow rate of no higher than 0.005 gallons per hour. The initial feed rate setting shall be such that a 1ppm effective dose of free chlorine shall be added to a flow stream of 10 gpm of clear water. Confirm appropriate setting during start-up in accordance with Section 3.3.
- F. Furnish metering pumps as manufactured by: LMI pumps, ProMinent Fluid Controls Inc., or approved equivalent.

- G. The metering pumps shall be installed with the suction line running from the top of the storage tank.
- H. Metering pumps shall be equipped with integrated check valves, or a check valve shall be installed on the line between the chemical storage tank and the pump.
- I. The metering pump assembly shall be equipped with a calibration tube adequately sized in volume for the design feed flow rate, and installed on the metering pump's suction line.

## 2.2 INJECTION FITTINGS/MAIN CONNECTION ASSEMBLIES

- A. Furnish main connection assemblies containing a PVC main probe with a length of 1 inch and a duckbill check valve. Connections shall be sized to match those on the pump.
- B. Injection fitting shall be equipped with a ball valve and a pressure relief valve set at 140 to 160 psi. The pressure relief valve shall be located on the pump side of the ball valve. Pressure relieve valves are not required for pumps that have automatic pressure relief protection.

## 2.3 TUBING

- A. Furnish low density polyethylene (LDPE), flexible tubing of the appropriate size and of adequate length for the application with a maximum pressure rating of at least 150 psi.
- B. Assure that all tubing is NSF approved for potable water applications.

## 2.4 STORAGE TANKS

- A. Furnish vertical, polyethylene storage tanks with a liquid level indicator clearly marked on the outside of the tank. Furnish two tanks, each with a capacity of 25 to 30 gallons, as manufactured by Norwesco, Inc, or approved equivalent. Provide two sets of clear and permanent markers for 5-gallon increments on opposing sides of each tank.
- B. Furnish tanks with two ¾ inch polypropylene threaded fittings, one for a drain and one for an overflow. Drain shall include a PVC ball valve and shall be located on the bottom of the tank, above the top of the containment basin. The overflow shall have a PVC outlet and free fall immediately to the containment tank. The bottom of the overflow outlet shall be located 3 inches below the top of the tank (effective maximum storage height to be 26 inches).
- C. Provide 12.5% solution liquid sodium hypochlorite complying to AWWA B300 with the tank in an amount equal to the maximum liquid level indicator.
- D. Provide tank stand as provided and recommended for use by the tank manufacture for the specific model being supplied. Assure that tank stand is proper height to place the bottom of the tank within an elevation of 0 to 6 inches above the top of the containment basin.
- E. Provide gasketed lids on the storage tanks and extend venting pipe through the building wall to atmosphere.

## 2.5 CONTAINMENT TANK

- A. Furnish a linear or cross-linked polyethylene secondary containment basin, complying with CFR 40.264.175 with a capacity equal to the capacity of each storage tank.
- B. Furnish basin with inside dimensions of 26-inch x 26-inch x 12-inch for each storage tank as manufactured by Indelco Plastics Corporation, or approved equivalent.

## 2.6 EQUIPMENT LABELS

- A. All equipment shall be provided with an attached, permanent valve label.
- B. Labels shall be a minimum of 2 inches by 4-inches with lettering etched into the label and conforming with all applicable OSHA requirements.
- C. Labeling tags shall be brass, aluminum or 1/8 inch fiberglass, Brady model 23084, or equivalent.
- D. Where colored valve tags are use, provide separate colors for separate control loops and separate vessels.
- E. Provide a label and flow arrow at each connection to pumps.

## 2.7 CHLORINE TESTING EQUIPMENT

- A. Provide chlorine testing equipment recognized in the latest edition of the Standard Methods for Examination of Water and Wastewater.
- B. Testing equipment must be capable of measuring residuals to the nearest 0.1 mg/l in the range below 0.5 mg/l; to the nearest 0.3 mg/l, for the range from 0.5 to 1.0 mg/l; and nearest 0.5 mg/l for the range from 1.0 to 2.0 mg/l.
- C. Provide Hach Portable Colorimeter Set for Total and Free Chlorine, with digital readout and pre-measured unit dose reagents, product # 5870023.

## PART 3 - EXECUTION

- 3.1 Install the chlorination equipment as indicated on the Contract Drawings and in strict accordance with manufacturer recommendations.
- 3.2 Have the manufacturer provide a qualified service representative for start-up and testing. Final approval of the chlorination equipment installation will not be awarded by the Engineer without the manufacturer providing a Manufacturer's Certificate of Proper Installation.
- 3.3 Demonstrate operation of metering pumps and injectors in on and off sequence via the automatic controls in, showing that the pump is activated with either well running. Demonstrate that injectors operate without any leakage or backflow. Confirm appropriate stroke setting during start-up through sampling, demonstrating a chlorine concentration between 0.8 and 1.1 mg/l for three consecutive readings in a 1 hour period.

## END OF SECTION

## **SPECIFICATION SECTION 11265**

### **ULTRAVIOLET DISINFECTION SYSTEM**

#### **PART 1 - GENERAL**

##### **1.1 WORK INCLUDED**

- A. Furnish and install a complete closed vessel, low pressure high output amalgam lamp, ultraviolet disinfection (UV) system as described in this specification and as shown on the Drawings. The Contractor shall be responsible for equipment installation per directions of the Manufacturer. The Manufacturer will be responsible for verification of system installation, start-up, testing, and operation and maintenance training of the Owner's personnel.
- B. The manufacturer shall guarantee that the system shall be capable of disinfecting public drinking water flow of 10 gpm as described in the operating parameters specified herein.
- C. These specifications are intended to give a general description of what is required, but do not cover all details that will vary in accordance with the requirements of the equipment application. It is, however, intended to cover the furnishing, shop testing, delivery, complete installation and field testing of all materials, equipment and all appurtenances required to complete the Work of this Section, whether specifically mentioned in these Specifications or not.

##### **1.2 SUBMITTALS**

- A. Submit, in accordance with Section 01300 proposed manufacturers data for the booster pump including:
  - 1. Dimensional drawings;
  - 2. Material Specifications;
  - 3. Five (5) operation manuals;
  - 4. A training plan that outlines the information that will be provided;
  - 5. Warrantee information.

#### **PART 2 – QUALITY ASSURANCE**

The UV unit shall be as manufactured by Aquionics, Inc. or approved equal. To be considered as an equal any alternate UV manufacturer must acquire approval from Montana DEQ for the referenced project prior to bid:

- A. To be considered, the manufacturer will be regularly engaged in the manufacture of UV systems with a proven track record of at least one hundred (100) municipal installations in North America.
- B. The manufacturer will provide documentation of previous experience with municipal UV disinfection systems in drinking water applications with electronic ballasts.



- C. Pre-qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including the number of lamps proposed, a detailed description of any exceptions taken to the specification and a complete set of equipment drawings.
- D. Submit complete biosimetry-based validation report prepared by an independent, third party with experience in the validation of UV disinfection equipment and evaluation of test data for development of performance models on the specific equipment being proposed. Validation testing must be conducted in accordance with the UVDGM (USEPA, 2006). Systems that are not validated or where the manufacturer wishes to conduct an onsite validation shall not be acceptable. The validated operational limits (referred to as the validation envelope) must include all design conditions and operational ranges including flow rate, UVT, relative lamp output (product of lamp aging and fouling factor) and RED. In addition, the validation report must contain the evaluation of UV system operational parameters, including:
  - 1. Total headloss curve constructed from a minimum of 5 points (minimum flow, maximum flow, and at least three intermediate points) that spans the operational flow range as presented in the Data Sheet.
  - 2. Relationship between UV intensity, UVT, power setting and number of operational lamps
  - 3. Relationship between UV system power consumption, power
- E. Documentation of UV manufacturer's service capabilities including location and experience.
- F. Sample disinfection performance guarantee including scope and duration of guarantee.

### **PART 3 - MATERIALS**

The Contractor shall furnish and install a complete low pressure high output amalgam lamp UV disinfection system as described herein. The system shall include, but is not limited to, a stainless steel disinfection chamber, low pressure high output amalgam lamps, automatic wiping system, power, and control equipment.

The UV system shall be rated for a maximum pressure of 200 psi and a working pressure of 150 psi.

The Contractor shall provide the power source, electrical conduit, electrical conductors, and equipment base supports. The Contractor shall physically install the disinfection chamber, power modules, and control modules according to the Manufacturer's directions and the drawings. The Contractor shall provide all power cables and make all necessary terminations.

The Manufacturer shall be responsible for verification of installation including conductors, electrical hookup of equipment, start-up, testing, and operation and maintenance instruction of the Owner's personnel.

Only companies with a minimum of 15 years experience and history of successful municipal water installations in North America of closed vessel UV systems will be considered. Pre-approved companies are as follows:

Aquionics Inc.  
21 Kenton Lands Rd.  
Erlanger, KY 41018  
Phone: (859) 341-0710

### 3.01 DESIGN CRITERIA

- A. *Performance.* The UV system will be designed in accordance with the 2006 USEPA ultraviolet disinfection Guidance Manual and be cable of delivering a 4-log reduction of cryptosporidium based on T1 as the challenge microorganism across all water quality parameters outlined within this specification. Alternate challenge microorganism can be submitted with proper testing documentation.
- B. *Head Loss.* The maximum allowable head loss across the UV reactor (flange-to-flange) at maximum design flow for a single UV reactor train in operation will be no more than 2 feet of head.
- C. *Power Supply Constraints.* The power supply requirements to the UV system will be 230V. Contractor to provide a 10 AMP Type D breaker per UV system.
- D. *Type of UV System.* The type of UV reactor components will be:
1. Closed vessel reactor
    - a. One (1) UV Chamber of type 316L stainless steel.
    - b. The chamber shall be capable of disinfecting up to 10 gpm of water.
    - c. Each chamber shall have an isolation valve (supplied by others) installed upstream and downstream of the UV system which will allow for isolation of the UV system from flow.
    - d. The disinfection chamber(s) shall be the following model: ProLine D140
      - i. Inlet/Outlet Connections: Threaded/Flange 2 inch.
      - ii. Vessel will be 55 inches in length (excluding wiper system) 84 inches with wiper.
    - e. Chamber will be equipped with an on-line pneumatic wiping system with operator settable wiping frequencies. Compressor will be supplied by the UV manufacturer. Air lines, valves, fittings, etc will be supplied by the contractor.
    - f. Chamber will be equipped with the necessary inlet and outlet connections for connection of a clean in place chemical cleaning system (provided by others).
  2. Control Panel
    - a. Electronics and controls will be housed in a single electronic control cabinet per vessel.
    - b. Cabinet is to be powder coated steel rated NEMA 4
    - c. Panel dimensions shall be 8" deep x 16" wide x 24" tall and is to be equipped with a door isolation switch to isolate the UV system for maintenance.
    - d. Cabinet shall have a front panel light for lamp on/off and fault indication.
    - e. Cabinet shall have a front panel light for "Wiper On", "Wiping", "Wiper Fault"
    - f. Cabinet shall have a two line LED display which will provide system operating status, fault conditions, intensity, DOSE and other parameters

- to assist with the operation of the UV system.
  - g. Cabinet will have customer courtesy contacts to monitor the UV system remotely and will include reset, fault, DOSE at a minimum.
  - h. Maximum distance of cabinet to vessel is 16 ft.
  - i. Interconnecting cables between the UV reactor and control cabinet will be supplied by the UV system manufacturer.
- 3. UV Lamp
  - a. One low pressure high output amalgam lamp per system is required.
  - b. Lamp will have a 140W input power.
- 4. UV Sensor
  - a. One sensor per lamp will be provided.
  - b. Sensor will be compliant with those stipulations listed in the 2006 USEPA Guidance Manual.
- 5. Automatic Wiping System
  - a. Automatic on-line pneumatically driven wiping system. Systems without automatic wiping shall not be acceptable.
  - b. Wiper rings will be of a UV resistant material such as Viton.
  - c. Wiping system will be driven by an industrial grade compressor supplied by the UV system supplier.
  - d. Air piping, fittings, connections and installation of the compressor will be made by the contractor.
  - e. Wiping controls will be field adjustable to allow for operators to adjust wiping frequency.
- 6. Piping Configuration
  - a. Upstream and downstream piping of the UV system must be compliant with the 2006 USEPA Guidance manual.
  - b. Piping must conform to the original equipment 3rd party validation.
  - c. Piping and UV system must fit within the UV system structure without modification.

## PART 4 - VALIDATION

### 4.01 GENERAL REQUIREMENTS

- A. All systems shall undergo full-scale, third party validation testing in accordance with the Environmental Protection Agency's Ultraviolet Disinfection Guidance Manual (Nov 2006 Final). Systems without a third party USEPA validation or systems where an on-site validation will be proposed are not acceptable.
- B. *Process.* The validation process must be based on:
  - 1. A challenge dosimeter (organism or appropriate particles) whose dose response behavior has been characterized and quantified with a Low Pressure Collimated Beam Apparatus in accordance with the Qa/Qc provisions itemized in the UVDGM.
  - 2. Identification and documentation of the critical components that impact dose delivery and operational stability and their technical and functional characterization (e.g., UV sensors, wetted dimensions, lamps, sleeves, etc).
  - 3. A documented validation envelope that includes upper and lower limits for power, flow and UVT.

4. A dose distribution characterization and or accounted for in the validation calculations (e.g., Dyed Microspheres, RED Bias ).
  5. Lamp aging and fouling characterization and computation.
  6. The validation testing must bracket the design criteria provided in the bid documents and specifications for a commissioned system.
- C. Validation Report. The validation report shall provide the headloss and power consumption calculations that were the basis of the sizing calculations and bid documents.
- D. The validation report shall also include a specific description of the hydraulic conditions of the validation testing and the validators' opinion of the hydraulic footprint and piping constraints implied by the validation testing configuration.
- E. *Documentation* The equipment manufacturer shall provide documentation and verification that the reactor shipped, "conforms uniformly" to the reactor validated and is programmed with the operating dose control methodology developed based on the validation report.

## **PART 5 - SPARE PARTS**

The following spare parts shall be supplied with the equipment (no less than enough spares for one chamber).

- 1 UV Lamp
- 1 Quartz Sleeve
- 1 O-ring Lamp Seal
- 2 Wiper Rings
- 1 Spare Sensor
- 1 Ballast
- 1 Operator Safety Kit (Face shield, gloves, signage)

## **PART 6 – EXECUTION**

### **6.01 MANUFACTURER'S ON-SITE SERVICES**

A Manufacturer's representative shall at a minimum perform the following tasks:

- A. Inspect, test and adjust the equipment after installation to verify mechanical, structural and electrical integrity and conformance to the equipment specifications. This task shall be scheduled for a maximum of two days.
- B. Instruct Owner's personnel in the proper operation and maintenance of the equipment at start-up.
- C. Provide additional services at no cost to the owner to correct any operational problems due to the design and/or fabrication of the ultraviolet disinfection equipment.

## **PART 7 - WARRANTIES**

The Manufacturer shall provide a written warranty that provides for:

- A. Warranty covers defects in equipment/material for one year from UV system acceptance or eighteen months from receipt of materials whichever occurs first.
- B. Performance guarantee is for 15 years or the life of the equipment whichever comes first and is based on:
  - 1. The equipment being operated at all times per the manufacturer's verbal and written instructions.
  - 2. Only original manufacture parts being used in all cases.
  - 3. Water quality parameters being within the specification at all times.
  - 4. Proper maintenance and operation logs being kept per manufacturer instructions.
- C. Lamps are provided with a 12,000 hour guarantee based on:
  - 1. No more than four on/off cycles in twenty-four hours of operation,
  - 2. The system being operated per the manufacturer's verbal and written instruction.
  - 3. Power having no more than 10% variance from that listed in the specification.
  - 4. If in the case a lamp fails prematurely, the manufacturer will take the following warranty guidelines:
    - a. Up to 9,000 hours of use – free replacement
    - b. 9,000 to 12,000 hours of use – prorated based on use

**END OF SECTION**

# **DIVISION 13**

## **SPECIAL CONSTRUCTION**

## **SECTION 13120**

### **CONCRETE UTILITY BUILDING**

#### **PART 1 - GENERAL**

##### **1.1 WORK INCLUDED**

- A. This specification covers the construction and placing of precast concrete utility buildings.

##### **1.2 SUBMITTALS**

- A. Submit, in accordance with Section 01300 proposed manufacturers data including: Dimensional drawings, Material Specifications, and Warrantee information.

#### **PART 2 - SPECIFICATIONS**

- ASTM C33 Concrete Aggregates
- ASTM C39 Method of Test for Compressive Strength of Cylindrical Concrete Specimens
- ASTM C143 Method of Test for Slump of Concrete
- ASTM C150 Standard Specification for Portland Cement
- ASTM C192 Method of Making and Curing Test Specimens in the Laboratory
- ACI 1211.1 Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete
- PCI MNL 116 Quality Control for Plants and Production of Precast Prestressed Concrete Products
- AWS D1.1 Structural Welding Code

#### **PART 3 - DESIGN CRITERIA**

- A. The precast concrete utility building shall meet the following design criteria. Calculations and Engineer's stamped drawings are to be provided with submittal. .
- B. Snow Load
  - 1. Building shall be designed for a snow load of 40 pounds per square foot.
- C. Wind Load
  - 1. Building shall be designed for a 180 mph (3 second-gust) Exposure C.
- D. Earth Quake
  - 1. Building shall be designed for a Zone 4 earthquake.
- E. Tolerances
  - 1. Tolerances will be within the limits as dictated by the PCI Quality Control and Assurance Manual.

## **PART 4 - MATERIALS**

### **A. Concrete - General**

1. This concrete mix design shall meet ACI 211.1 to produce concrete of good workability.

Mix #7.25 R - 1 cubic yard

cement 681 lbs.

water 232 lbs. (27.8 gal.)

w/c=.34

Course aggregate (SSD) 1,800 lbs.

Fine aggregate (SSD) 1,196 lbs.

Water Reducing Agent 34 oz. MB 322N

Air Entraining Agent 6 oz. MB AE-90 (4-7%)

Ave. 28 day strength 5,500 psi

2. Cement shall be low alkali type I-II or type III conforming to ASTM C-150
3. Coarse aggregates used in the concrete mix design must conform to ASTM C33 with the designated size of coarse aggregate #67.
4. Minimum water/cement ratio shall not exceed 0.40. Slump shall not exceed 5" with normal water reducing agent or 7" with super plasticizer.
5. Air-entrained admixtures shall conform to ASTM C260. Water reducing admixtures shall conform to ASTM C494, Type A. Plasticizing admixtures shall conform to ASTM C1017. Other admixtures will not be used without Owner approval.

### **B. Colored Concrete**

1. Color additives shall conform to ASTM C979. A 6"x12"x2" color sample must be available for customer approval.
2. The following will contain colored concrete:
  - a. Utility Building roof panels
  - b. Building walls
  - c. The sample brand and type of color additive will be used throughout the manufacturing process.
  - d. All ingredients will be weighted and the mixing operation will be adequate to ensure uniform dispersion of the color.

### **C. Cold Weather Concrete**

1. Cold weather concrete placement shall be in accordance with ACI 306.
2. Concrete will not be placed if ambient temperature is expected to be below 35 degrees F. during the curing period unless heat is readily available to maintain the surface temperature of the concrete at least 45 degrees F.
3. Materials containing frost or lumps of frozen materials shall not be used.

### **D. Hot Weather Concrete**

1. The Temperature of the concrete shall not exceed 80 degrees F. at the time of placement and when the ambient temperature reaches 90 degrees F. The concrete must be protected with moist covering.



- E. Concrete Reinforcement
1. All reinforcing steel shall conform to ASTM A615. All welded wire fabric shall conform to ASTM A185.
  2. All reinforcement must be new, free of dirt and oil. Paint, grease, and loose mill scale and loose or thick rust shall be removed prior to reinforcement placement.
  3. Details not shown on drawings or specified shall conform with ACI 318.
  4. Steel reinforcement shall be centered in the cross-sectional area of the walls and must have at least 1" of cover on the under surface of the floor and roof.
  5. Full lengths of reinforcing steel must be used when possible.
  6. Reinforcing bars shall be bent cold.
  7. Diagonal reinforcement shall be placed around all openings.
- F. Sealers and Curing Compounds
1. Curing compounds, if used, must be odorless, complying with ASTM C309 type I or I-D.
  2. Weatherproofing sealer for exterior of building shall be clear, low gloss, water based acrylic sealer (Dayton-Superior J-24).
- G. Caulking, Grout, Adhesive and Sealer
1. All caulking shall remain flexible and non-sag at temperatures from 50 to 140 degrees Fahrenheit.
  2. Interior joints shall be caulked with white "Sidewinder" by DAP.
  3. Exterior joints shall be caulked with a siliconized acrylic caulk that closely matches the exterior concrete color (by GE Sealants). Roof ridge must be 100% silicon caulk (also by GE Sealants).
  4. Epoxy concrete adhesive shall be two component rigid, non sag gel adhesive for bonding to dry or damp surfaces, moisture insensitive.
  5. Portland cement mortar shall consist of one part Portland cement, three parts sand and enough water to make a workable mixture
- H. Paint
1. All paints and materials shall conform to all Federal specifications or be similar "top-of-the-components". Paints will be lead free.
    - a. Inside concrete surfaces
      - i. Interior floors shall be a 2-part water based epoxy (AQUA TILE by INSL-X) The color will be gray.
      - ii. Interior walls and ceiling shall be a 100% acrylic emulsion, Mirrorlac-WBDP84XX by DEVOE / GLIDDEN. The color will be white.
    - b. Metal surfaces both inside and out.
      - i. Primer and enamel - Mirrorlac DP85XX by DEVOE / GLIDDEN
    - c. Exterior concrete surfaces
      - i. Exterior walls shall be a pure acrylic water repellent penetrating stain in the same color as the walls followed by a clear acrylic sealer. Stain enhanced with Wondershield by DEVOE / GLIDDEN. DR15XX
      - ii. Simulated shake roofs shall receive one heavy coat of pure linseed oil.

- I. Steel Doors
  - 1. Doors shall be flush panel type 1-3/4" thick, minimum 18 gauge prime coated steel panels with minimum 16 gauge internal bracing channels with rigid insulated core.
  - 2. Door frames shall be knockdown or welded type, single rabbet, minimum 16 gauge prime coated steel width to suit wall thickness. Three (3) rubber door silencers will be provided on latch side of frame.
- J. Door Hinges
  - 1. Door hinges shall be 3 per door with dull chrome plating 4 1/2"x 4 1/2", adjustable tension automatic-closing for each door.
- K. Door Hardware
  - 1. Lockset shall meet ANSI A156.2 Series 4000, Grade 1 cylindrical lockset for exterior doors.
  - 2. Lever handle both inside and out.
  - 3. U.S. 26D finish.
- L. Door Louvers
  - 1. Door louver will be fixed, inverted split Y, non-vision, 18 gauge cold rolled steel with a factory prime coat equal to FDL series.
- M. Doorstop
  - 1. Door stop shall have a cast metal base, US 26D finish, and hook latch for holding the door in the open position.
- N. Door Sweep
  - 1. Door sweep shall be provided at the bottom of door and must be an adjustable brush type, or rubber as requested by the customer.
- O. Threshold
  - 1. Threshold shall be extruded aluminum of a thickness to provide a maximum clearance of 3/8" between threshold and bottom of door.

## **PART 5 - EXECUTION**

- A. Mixing and Delivery of Concrete.
  - 1. Mixing and delivery of concrete shall be in accordance with ASTM C94, section 10.6 through 10.9 with the following additions.
  - 2. Aggregate and water will be adjusted to compensate for differences in the saturated surface-dry conditions.
  - 3. Concrete shall be discharged as soon as possible after mixing is complete. This time will not exceed 30 minutes.
- B. Placing and Consolidating Concrete
  - 1. Concrete must be consolidated by the use of mechanical vibrators. Vibrations will be sufficient to accomplish compaction but not to the point that segregation occurs.

- C. Finishing Concrete
1. Interior floor and exterior slabs shall be floated and troweled until all marks are removed. A light broom finish shall be applied to the exterior and interior slabs for a non-slip finish.
  2. All exterior building walls and exterior screen walls shall be a barnwood texture, unless otherwise specified.
  3. All exterior surfaces of the roof panels shall be cast to simulate a cedar shake roof, unless otherwise specified. The underside of the overhang will have a smooth finish.
- D. Cracks and Patching
1. Cracks in concrete components that are judged to affect the structural integrity of the building will be rejected.
  2. Small holes, depressions and rock pockets shall be patched with a suitable material. The patch must match the color, finish and texture of the surrounding surface.
  3. Patching will not be allowed on defective areas if the structural integrity of building is affected.
- E. Curing and Hardening Concrete
1. Concrete surfaces will not be allowed to dry out from exposure to hot, dry weather during the initial curing period.
  2. Curing compounds shall not be used on interior walls as they will prevent paint adhesion.

## **PART 6 - FINISHING AND FABRICATION**

- A. Structural Joints
1. All welding shall be by Certified Welders only (in accordance with AWS D1.1).
  2. Wall components shall be joined together with 2 welded plate pairs at each joint. Weld plates must be anchored into the concrete panels and welded together with a continuous weld.
  3. Walls and roof shall be joined with weld plates, 2-1/2"x5", at each building corner.
  4. The joint between the floor slab and walls shall be joined with a grout mixture on the inside, a matching colored caulk on the outside and two weld plates 6" long per wall.
- B. Painting
1. An appropriate curing time shall be allowed before paint is applied to concrete.
  2. Painting shall not be done outside in cold, frosty or damp weather.
  3. Painting shall not be done outside in winter unless the temperature is 50 degrees Fahrenheit or higher.
  4. Painting shall not be done in dusty areas.
  5. Schedule of finishes:
    - a. Inside concrete surfaces
      - i. Inside floors shall be 2 coats of 2-part water based epoxy.
      - ii. Interior walls and ceiling shall be one coat primer / filler and 2 coats of white water based acrylic emulsion.
    - b. Metal surfaces both inside and out

- i. 1 coat primer and 2 coats of enamel
  - c. Exterior concrete surfaces
    - i. Exterior slab shall be 1 coat of clear sealer.
    - ii. Stained enhanced exterior walls shall be 1 coat of pure acrylic water repellent penetration stain in the same color as the walls or roof followed by 1 coat of clear acrylic sealer.

## **PART 7 - QUALITY CONTROL AND INSPECTION**

- A. Pre-pour inspection.
  - 1. Check all panel measurements including diagonals (must be within ¼ inch).
  - 2. Check rebar spacing and clearance
  - 3. Check location of all embeds.
- B. Concrete Testing
  - 1. The following tests shall be performed on concrete used in the manufacture of the precast concrete building. Testing must be performed by qualified individuals who have been certified ACI Technician Grade 1. Sampling will be in accordance with ASTM C172.
    - a. The slump of the concrete shall be performed on the first batch of concrete in accordance with ASTM C143. This slump must be in the 3"-5" range for mixes with normal water reducing agents, and 3"-7" range for super plasticized mixes.
    - b. The air content of the concrete shall be checked per ASTM C231 on the first batch of concrete. The air content must be in the range of 4%-6%.
    - c. The compressive strength of the cylinders shall be tested to ASTM C39.
    - d. Test cylinders shall be taken from each other batch.- 1 cylinder must be tested prior to removal of forms and must be at 2,500 psi or higher.- 1 cylinder represents 7 day strength - 2 cylinders will represent 28 day strength and must be 4,500 psi or greater.
- C. After Form Removal Inspection
  - 1. Recheck panel dimensions
  - 2. Verify that all embeds remained in place.
  - 3. Look for all cracks or blemishes that may cause rejection.
  - 4. Assure that panels are properly yarded and blocked.

## **PART 8 - INSTALLATION**

- A. Scope of Work
  - 1. Work specified under this Section includes excavation, backfill and placement of a precast concrete utility building.
- B. Materials
  - 1. Bedding material to be sand or 3/4" minus crushed or screened aggregate.
- C. Placement
  - 1. Buildings Placed Upon Compacted Gravel Pad.

- a. Care must be taken to allow slack in electrical wire entries and swing joints or flexible pipe in plumbing entries as the building will be subject to several inches of up and down movement during frost cycles.
- b. Oversize penetrations in floor slab for pipe or electrical entries. Place sand or screened gravel in the extra space, DO NOT GROUT.
- c. Backfill exterior of building up to finished floor elevation allowing drainage away from the structure.

**END OF SECTION**

## **SECTION 13200**

### **FIBERGLASS REINFORCED UNDERGROUND WATER STORAGE TANK**

#### **PART 1: GENERAL**

##### **1.1 DESCRIPTION**

- A. The Contractor shall be responsible for all labor, materials and equipment necessary for the design, fabrication, construction, disinfection and testing of a below-grade fiberglass reinforced potable water storage tank. Only new tanks constructed of new, unused materials shall be accepted. Design and construction of the tank shall conform to all requirements of AWWA D120-84(R89).
- B. Construction of the tank shall include fabrication, placement, cleaning, testing, disinfection, installation of all ladders, risers, safety equipment, and accessories as herein specified, ventilation, controls, piping, and connection to the water main.

##### **1.2 REFERENCES**

- A. AWWA D120-84 Thermosetting Fiberglass-Reinforced Plastic Tanks.
- B. AWWA C652 Disinfection of Water-Storage Facilities.

##### **1.3 GOVERNING STANDARDS**

- A. The tank shall be manufactured according to the requirements of ANSI/AWWA D 120-84(R89)
- B. The tank shall be manufactured with materials conforming to the requirements of FDA regulation Title 21 CFR 177.2420.
- C. The laminate materials used in the internal coating system shall conform to the requirements of NSF Standard 61.
- D. The raw materials used in the resin shall comply with FDA regulation Title 21 CFR, Parts 180-199, for use in contact with food.

##### **1.4 SUBMITTALS**

- A. The Contractor shall submit to engineer 4 copies of shop drawings and 4 copies of manufacturer's literature (including installation instructions).

##### **1.5 GUARANTEE**

- A. All guarantees obtained by the Contractor from the manufacturer or installer of the storage tank and any included accessories not manufactured by the Contractor shall be obtained for the benefit of the Owner.

## **PART 2: PRODUCTS**

### **2.1 SINGLE-WALL FIBERGLASS UNDERGROUND TANKS**

- A. Product-Storage Requirements:
  - 1. The tank must be vented to the atmosphere.
  - 2. Tank to be Xerxes or approved equivalent.
  - 3. Tank shall be specifically constructed to store potable water with NSF approval.
- B. Tank Dimensions:
  - 1. Tank shall have a minimum nominal capacity of 5,000 gallons.
- C. Loading Conditions – Tanks shall meet the following design criteria:
  - 1. External pressure: The tank shall exhibit a minimum 5:1 safety factor against buckling when empty, with a 6' soil and hydrostatic burden over the top.
  - 2. Internal Load: Tank shall withstand 5 psi air pressure test with a minimum 5:1 safety factor.
  - 3. Tanks shall be designed to support accessory equipment such as ladders, drop tubes, etc. when installed according to manufacturer's recommendations and limitations.
  - 4. Tank must maintain structural shape. Deflect in diameter shall be less than 2% following installation backfill and compaction.
- D. Materials:
  - 1. Tank shall be manufactured with 100% resin and glass fiber reinforcement. No sand fillers will be allowed.
  - 2. Tank is to be post cured.
    - a. Post curing shall be performed at a temperature of at least 180° F for a minimum of 4 hours.
    - b. Hot air for post cure shall be generated by heaters fired by a clean burning fuel or electricity. Kerosene fired heaters shall not be used.

### **2.2 ACCESSORIES**

- A. Manway Access:
  - 1. The manway access shall be dimensioned and located as shown on the plans.
  - 2. Manway access shall have a hinged and lockable lid with a 2 inch minimum lip extending down over the barrel and shall be water tight.
- B. Ladders:
  - 1. Manway access shall be provided with a molded fiberglass internal ladder with fiberglass mounting brackets laminated in place. Stainless steel attachment bolts shall be provided.
  - 2. Ladders for potable water tanks shall be manufactured with materials conforming to the requirements of NSF Standard 61.
- C. Piping and Fittings:
  - 1. The tank must be provided with a 4 inch galvanized vent.
    - a. Vent shall terminate in an inverted U construction with the opening 36 inches above finished grade.
    - b. Vent shall be covered with 24 mesh stainless steel screen.

2. Tanks shall be capable of storing potable water not to exceed 150° F at the tank interior surface.
  3. The tank must be provided with a 2 inch galvanized overflow.
    - a. Overflow shall open downward and be covered with 24 mesh stainless steel screen or as indicated on plans.
  4. All standard threaded fittings shall be NPT half couplings.
  5. Level float access port shall be located as shown on the plans. Port shall be a 2 inch diameter female NPT half coupling
- D. Lifting Lugs:
1. The combined capacity of designated lifting lugs shall be 2 times the empty tank weight.

### 2.3 PEA GRAVEL

- A. Provide pea gravel that is a mix of rounded particles, between the sizes of  $\frac{1}{8}$  inch and  $\frac{3}{4}$  inch conforming to Paragraph 9.1 of ASTM C33.
- B. No more than 5% (by weight) of the pea gravel may pass through a No. 8 sieve.
- C. Assure the material is clean, free flowing, non-corrosive, inert, and free of ice, snow, or debris.

## **PART 3: EXECUTION**

### 3.1 INSTALLATION

- A. Tank shall be installed according to the current installation instructions provided by the tank manufacturer.

### 3.2 TESTING

- A. Tanks shall be tested according to the current installation instructions provided with the tank or as outlined in these specifications
- B. Testing instructions and procedures:
  1. After tank installation, pressurize the tank to 5 psig and allow pressure to stabilize by adding or removing air as necessary.
  2. Close air-supply on the test manifold and disconnect the air-supply line.
  3. Monitor pressure for a minimum of 1 hour.
  4. Any leaks disclosed by this test shall be corrected in accordance with the manufacturer's recommendations.

### 3.3 DISINFECTION

- A. Disinfect tanks subject to the Engineer's approval in accordance with AWWA C652, "Disinfection of Water-Storage Facilities", and these specifications before placing tanks in service.
- B. The forms of chlorine that may be used, subject to the approval of the Engineer are:



1. Liquid chlorine meeting the requirements of Section 4.2.1 of AWWA C652. Use liquid chlorine only in combination with appropriate gas-flow chlorinators and ejectors.
  2. Sodium hypochlorite meeting the requirements of Section 4.2.2 of AWWA C652.
  3. Calcium hypochlorite (HTH) is not acceptable.
- C. Two methods of chlorination may be used, the continuous feed method per Section 4.3.1 of AWWA C652 or the solution coating method per Section 4.3.2 of AWWA C652. The continuous feed method provides a 6 hour free chlorine residual of 10 mg/L, and the solution coating method coats all surfaces in the tank with a solution of 200 mg/L available chlorine.
1. Continuous Feed Method
    - a. Fill the new tank to the overflow level at a constant, measured rate with water from the existing distribution system or another approved source.
    - b. Continuously feed chlorine, at minimum 25 mg/L free chlorine, to the water entering the tank during filling through an appropriate valve located on the inlet pipe and near the tank. Measure the chlorine concentration at regular intervals to assure that this concentration is provided.
    - c. Apply liquid chlorine with a solution feed vacuum operated chlorinator in combination with a booster pump or through another approved method. Apply sodium hypochlorite by means of a chemical feed pump designed for feeding chlorine solutions.
    - d. Retain the chlorinated water in the new tank for a minimum of 6 hours after filling with chlorinated water. At the end of the 6 hour period, demonstrated to the Engineer's satisfaction a free chlorine residual of not less than 10 mg/L in the tank.
  2. Solution Coating Method
    - a. Thoroughly coat the surfaces of all parts of the new tank that will come into contact with water with a solution of 200 mg/L available chlorine. Apply the chlorine solution with suitable brushes or spray equipment.
    - b. Maintain the contact between the disinfected surfaces and the strong chlorine solution for at least 30 minutes. After the 30 minute period, fill the tank to the overflow level with water from the existing distribution system or another approved source.
- D. The "super chlorination" method outlined in Section 4.3.3 of AWWAC652 is not an acceptable method of disinfection.
- E. Final Flushing
1. After filling the new tank and the required retention periods, reduce the chlorine to a concentration no higher than that in the existing distribution system by completely draining the tank and refilling with potable water or by a combination of additional holding time and blending with potable water having a low chlorine concentration.
  2. If draining the tank of the highly chlorinated water, add a reducing agent or otherwise thoroughly neutralize the chlorine residual in the water as required by Federal, State, or local environmental regulations. Contact the proper authorities prior to the disposal of the highly chlorinated water.

- F. Bacteriological Tests
  - 1. After final flushing and before the tank is placed in service, test a sample, or samples, collected from the tank for organisms.
  - 2. If the test for organisms is negative, the tank may be placed into service.
- G. If the initial sample indicates the presence of organisms, repeat the sampling and testing until two consecutive samples are negative for organisms. Completely drain and re-disinfect the tank until approved results are obtained if two consecutive negative samples cannot be collected.

**END OF SECTION**

# **DIVISION 15**

## **MECHANICAL**

## SECTION 15505

### HEATING AND VENTILATING

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. This section covers the heating and ventilating systems, including all equipment, fittings, controls, ducts, devices, accessories, and appurtenances necessary for complete, properly operating systems. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or specified herein are covered in other sections.

##### 1.2 GENERAL

- A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- B. Equipment furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
- C. All equipment furnished under this section of the specifications which is provided with combination motor starters and disconnects shall be furnished by the mechanical contractor in compliance with the electrical section.
- D. Coordination. The Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
- E. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section.
- F. Elevation. All values given herein are for site conditions at an elevation of 4,800 feet above sea level. It shall be the responsibility of the Contractor to meet stated specification requirements with all equipment.
- G. Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.
- H. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, inserts, supports, and other accessories which are required for heating and ventilating work shall be furnished and installed.
- I. Shop Painting. Unless otherwise specified, all ferrous sheet metal surfaces other than ductwork shall be given a rust-inhibiting treatment consisting of galvanizing or

bonderizing followed by a rust-inhibitive primer and finish coat. Surface finish damaged during installation shall be repaired to the satisfaction of the Engineer. Field painting shall be as specified in the painting section.

### 1.3 CODES AND PERMITS

- A. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or municipal ordinance, the latter shall govern. All work shall comply with Underwriters' Laboratories (UL) safety requirements.

### 1.4 IDENTIFICATION

- A. All equipment, ductwork, panels, and control equipment denoted by a symbol and an identifying number shall be provided with equipment identification plastic nameplates, plastic tags, metal nameplates, or metal tags. Mechanical identification used shall be the same as the symbols indicated herein or on the drawings and shall be located in a conspicuous place.
- B. Plastic nameplates and tags shall be laminated phenolic not less than 1/8 inch thick and shall be black with white core. Metal nameplates and tags shall be not less than 12 gage thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches. Nameplates shall be installed with corrosion-resistant mechanical fasteners. Individual equipment and components too small to accommodate the specified nameplates shall be identified with tags. Tags shall be installed with corrosion-resistant chains or straps.
- C. Mechanical Equipment. All mechanical equipment shall be identified with nameplates. In addition, each major component of equipment shall have the manufacturer's name, address, and catalog number on a nameplate securely affixed. The nameplate of the distributing agent only will not be acceptable.

### 1.5 SUBMITTALS

- A. Complete assembly and installation drawings and wiring and schematic diagrams, together with detailed specifications and data covering material used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with the general requirements section. Device tag numbers indicated on the Contract Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications shall include, but shall not necessarily be limited to, the following:
- B. Fans
  - 1. Name of manufacturer.
  - 2. Type and model.
  - 3. Construction materials, gages, and finishes.
  - 4. Overall dimensions and required clearances.
  - 5. Net weight and loading distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model with capacity in cubic feet per minute as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for a minimum of 3 different speeds.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data should list dB re  $10^{-12}$  watts in each octave band with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Schematic control wiring diagrams showing multiline wiring for the unit and all interconnecting devices. Wiring diagrams shall be detailed to the degree required for field construction with all terminals identified.

C. Equipment

1. Name of manufacturer.
2. Type and model.
3. Manufacturer's data.
4. Overall dimensions.
5. Net weight and loading distribution.
6. Wiring diagrams.

D. Temperature Controls. Prior to the performance of any Work or installation of any materials, the Contractor shall submit the following data in accordance with the submittals section:

1. Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and noted with the identification designation used herein and on the drawings.
2. Schematic control diagrams giving specific data on all settings, ranges, action, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual systems with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. Wiring diagrams shall be detailed to the degree required for field construction and shall include all related wiring.
3. Sequence of operation for each system corresponding to the control schematics.
4. Space thermostat schedule indicating the types of covers and adjustment means for each space.
5. All conduit and wiring as necessary for a complete and functional system.
6. All temperature control conduit and wiring shall be furnished and installed by the temperature control contractor in compliance with the electrical section for all materials furnished.

## PART 2 - PRODUCTS

### 2.1 HEATERS

- A. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the drawings and in the schedules. All heaters shall be complete with controls and accessories as required for satisfactory operation. All electric heaters shall be UL listed.
- B. Electric Unit Heater. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall be furnished and installed where indicated on the drawings. Each heater shall be of the type, size, and capacity indicated herein. The heater shall be fully UL approved, designed for either wall or ceiling mounting without modification.

The housing cabinet shall be of heavy gauge steel, welded and phosphatized; then completely painted by a baked enamel painting process. Front and back panels shall be removable to gain full access to element, motor and fan area. Fan guard shall be painted to match heater for appearance and durability. Heaters shall be furnished with attached ceiling mounting bracket and shall have capability of full horizontal and vertical position. Heater shall be mounted within two inches of the ceiling in full horizontal mode.

The control box, housing all heater wiring and controls, shall be located at the bottom of the heater and equipped with a swing-down hinged cover to permit full access for installation, and for cleaning and servicing without dismounting the heater.

All heater and control wiring connections shall terminate in the control box. Proper wiring diagram shall be attached to the inside of the control box cover. 60°C wiring must be used to enter the wiring compartment.

Fan motor shall be totally enclosed, impedance protected and of unit bearing design suitable for horizontal or vertical operation with starting and running torques. Fan motor and controls shall operate directly from the line voltage.

The heating element shall be warranted for five years and shall be of non-glowing design consisting of a special resistance wire enclosed in the steel sheath to which steel plate fins are brazed. The heating element shall cover the entire air discharge area for uniform heating.

Each unit heater shall be furnished complete with a 24 volt transformer and shall include all required limit and safety controls. A single stage low voltage thermostat is to be remote mounted to control the unit heater.

Thermal cutout shall be attached directly to each bank of elements to shut off the heater in the event of overheating and reactivate the heater when temperatures return to normal.

The heater shall be suitable for use with a 240 volt, 60 Hz, single phase power supply and shall be provided with automatic reset thermal overload protection.

**The Electric Unit Heater EUH-1 shall be a BERKO HUH-524TA, or approved equal, with output of 17,000 BTUH.**

- C. Gas Unit Heaters. None required.
- D. Electric Wall Heater. None required.

## 2.2 FANS

- A. Fans of the types, sizes, and capacities specified shall be furnished and installed where indicated on the drawings. Each fan shall be complete with electric drive motor, drive, and accessories as required for satisfactory operation. Where belt- driven fans are furnished, each fan shall be complete with V-belt drive designed for 50 percent overload capacity, adjustable sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable sheaves shall be furnished and selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range.

Fans shall be rated in accordance with AMCA standards, or shall bear the AMCA Certified Rating Label, and shall be UL listed.

Fan drive motors and controls shall conform to the requirements of the Electric Motors and Motor Controls paragraph. Motor horsepower in the Fan Schedule are minimum motor horsepower. Larger motors shall be provided if required to meet the specified requirements.

Fan curves with the specified operating point clearly identified shall be furnished with the fan submittals. The fan curves should include a family of curves for a minimum of three different rotative speeds. The fan curves shall include brake horsepower information.

Fan noise level tests and ratings shall be made and published in accordance with AMCA Standards 300 and 301. Fan sound ratings and sound test verifications shall be furnished with each fan submittal.

The static pressure values indicated herein are external to the complete unit. Internal fan housing losses are not included.

- B. Exhaust Fan. Exhaust fan EF-1 shall be frame mounted fan of the panel mount direct drive type. The fan housing shall be of the square or rectangular design, constructed of heavy gauge galvanized steel and shall include frame mounting collars. The fan wheel shall be constructed of aluminum. Blades shall be statically and dynamically balanced.

Fan motors shall be permanently lubricated and carefully matched to the fan loads. Motors shall be readily accessible for maintenance. A NEMA 1 disconnect switch shall be provided as standard. Factory wiring shall be provided from motor to the handy box. All fans shall bear the AMCA Certified Rating Seal for both sound and air performance. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification. Motors shall be totally enclosed and shall be suitable for use with 120 volt, single phase power supply.

The exhaust fan shall be mounted in a sheet metal enclosure at the inside face of louver-damper LD-2. The exhaust fan shall have capacities as indicated below:

Designation

EF-1



Airflow, cfm	575
External static pressure, in. W.C.	F.A.
Min motor horsepower	1/30
Drive type	Direct

**Exhaust fan EF-1 shall be Greenheck Model SEI-10-424-D-1, or approved equal.**

## 2.3 LOUVER-DAMPER

- A. Dampers of the types and sizes specified shall be furnished and installed where indicated on the drawings.
- B. Intake Louvers. The wall opening for intake air shall be equipped with an intake louver to prevent entry of wind driven precipitation. Louvers shall be constructed from extruded aluminum sections. Intake louver L1 shall be 16 inches high by 16 inches wide and shall mount on the exterior of the building as shown on the drawings.
- C. Combination Louver-Dampers. Combination type louver-dampers shall be furnished and in stalled where indicated on the drawings. Sizes shall be as indicated. Combination type louvers-dampers shall be constructed of extruded aluminum sections, frame sections 0.125 inch thick, securely assembled to form a sturdy, rigid unit. The exterior blades shall be fixed; the interior blades shall be movable. Combination louver-dampers shall be installed as specified for weather louvers and shall be calked as specified in the caulking section. The exterior frame shall be flanged. Bird screens of 1/2 inch mesh aluminum shall be furnished and installed on all units. Dampers shall be motor operated.

Where aluminum work is to be attached to steel supporting members, or other dissimilar metal, the aluminum shall be kept from direct contact with such metals by a heavy shop coat of coal tar paint. Aluminum surfaces which will be in contact with concrete or masonry when installed shall be given a heavy coat of coal tar paint. All paint shall be dry and hard when the coated parts are shipped, assembled, or installed.

Aluminum work which will be exposed to the exterior after installation shall be given a baked enamel finish to match building trim.

The combination louver-dampers shall be as shown on the drawings.

CLD shall be 16 inches wide by 16 inches high by 6 inches and located as indicated on the drawings.

**Combination Louver-Damper LD-1 shall be Greenheck ECD 601, or approved equal.**

## 2.4 DAMPER OPERATORS

- A. The damper operators shall be complete with necessary linkage and mounting brackets and shall be installed for each motorized damper as indicated on the drawings.

A maximum of 25 square feet of control damper shall be controlled by one damper operator. The operators shall have sufficient torque required to operate the damper.

The electric damper operators shall be two-position type.

Two-position electric damper operators shall be housed in a die-cast aluminum case with mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch square, double-ended drive shaft.

Damper operators shall be two-position type with spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Where auxiliary transformers are required, the transformer shall be factory wired to the damper operator and installed in a NEMA Type 1 rated enclosure fastened to the motor housing.

Two-position electric damper operators shall be Multi Products MP-2985E or equal.

## 2.5 TEMPERATURE CONTROLS

- A. The automatic temperature control systems shall be furnished and installed as indicated on the drawings and as specified herein. All temperature controls shall consist of electric equipment as specified and shall be the product of a single manufacturer, unless otherwise indicated.
- B. The electrical control components shall be as manufactured by Johnson Controls or Honeywell. The control apparatus shall consist of all necessary thermostats, control valves, switches, relays, and gages as indicated on the drawings and as specified herein.
- C. Selector Switches. Selector switches shall be heavy-duty, oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or equal.
- D. Indicating Lights. Indicating lights shall be heavy-duty, push-to-test, oiltight type, which utilize a low-voltage lamp and a built-in transformer. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or equal.
- E. Thermostats. Thermostats shall be as specified herein. Wall-mounted thermostats in non-air-conditioned areas shall be furnished and installed with a wire or cast-aluminum guard. Wall-mounted thermostats shall be mounted 5'-6" above finished floors.

Insulating spacers for thermostats mounted on exterior building walls shall be provided. The spacers shall be installed between the thermostat and its mounting surface so that the thermostat will not be affected by surface temperatures.

Thermostats for control of unit heaters shall be single-stage, low voltage thermostats.

The thermostats shall have a range of approximately 40°F to 90°F with an adjustable differential and shall be supplied with the unit heaters.

- F. Damper Operators. Damper operators shall be furnished as specified in the Damper Operators paragraph. The number of damper operators furnished for each damper shall provide the torque required to operate the damper.
- G. Accessory Components. All additional control components, such as electric relays, temperature sensors and transmitters, controllers, and position switches, shall be furnished as required to ensure a complete, properly operating installation. Components shall be products of the temperature control manufacturer. Accessory components shall be furnished with equipment enclosures.
- H. Electrical Wiring. Detailed wiring diagrams shall be submitted in accordance with the general requirements section. The wiring diagrams shall show all field wiring to equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.
- I. Emergency Ventilation Key Operated Switch. None required.

## 2.6 SEQUENCE OF OPERATION

- A. Sequence of operations for the temperature controls system shall be as follows.
  - 1. Heating. Electric Unit Heater EUH shall be controlled by single stage Thermostat T-1. The thermostat shall energize EUH.
  - 2. Ventilation. Exhaust fan EF-1 shall be controlled by the building thermostat. When the thermostat reaches the "set temperature", combination louver-damper LD-1 shall open and EF-1 shall be energized. LD-1 and shall be proven open before EF-1 can operate.
  - 3. ELECTRIC MOTORS AND MOTOR CONTROLS. The following requirements apply only to electric motors and motor controls which are not covered in other sections.

Motors shall conform to the requirements of the General Equipment Stipulations. One-half horsepower and larger motors shall be energy- efficient type. Motor starters and controls shall be furnished under the electrical section.

All electrical controls, including disconnect switches and thermostats shall have a case or cabinet suitable for the NEMA ratings indicated on the electrical drawings. Disconnect switches shall be furnished at all electric motors for all electrical equipment.

Typical schematics on the drawings indicate electrical control items and functions required for most of the equipment; however, actual motor sizes shall comply with the General Equipment Stipulations.

## **PART 3 - EXECUTION**

### **3.1 TESTS**

- A. All tests shall be conducted in a manner acceptable to the Engineer and shall be repeated as many times as necessary to secure the Engineer's acceptance of each system.
- B. Completed Systems. After completion of the heating and ventilating systems, tests shall be conducted to demonstrate that each system is functioning in accordance with specification requirements and to the satisfaction of the Engineer.
- C. Defective Work. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

### **3.2 CLEANING**

- A. At the completion of the test work, all parts of the installation shall be thoroughly cleaned. All equipment, pipes, valves, and fittings shall be cleaned of grease, metal cuttings, and sludge which may have accumulated by operation of the system for testing.  
  
Any stoppage, discoloration, or other damage to parts of the building, building finish, or furnishings shall be repaired at no additional cost to the Owner.

### **3.3 AIR SYSTEM TESTING AND BALANCING**

- A. The Contractor shall provide the services of a licensed independent contractor, certified by NEBB or AABC, who shall perform operational testing, adjusting, and balancing of the air systems. The contractor performing the adjusting and balancing shall be able to provide past experience qualification data on at least three similar projects.
- B. All instrumentation shall be calibrated within six months of use and shall be checked for accuracy before testing, adjusting, and balancing the air systems. The instrumentation accuracy shall not be less than that specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.
- C. All data, including system deficiencies encountered and corrective action taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, the Contractor shall notify the Engineer in writing as soon as practicable.
- D. All belt guards, panels, and doors removed during the testing, adjusting, and balancing operation shall be reinstalled.

Before the air system testing and balancing operations, doors and windows surrounding the areas served by the air system to be balanced shall be closed. The fans shall be checked for the correct rotation and rotative speed. Access doors and panels shall be closed during the testing and balancing operations.

- E. Air systems shall be adjusted to the design airflows indicated on the drawings and in the schedules. Airflows shall be adjusted to maintain a net positive (supply airflow greater

than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the drawings.

- F. Dampers with damper operators shall be checked for tight shutoff when in the Closed position.
- G. Complete apparatus report sheets for all air systems shall be accurately and completely filled out. Copies of the final test readings and one copy of the Standard Procedure Manual shall be submitted in accordance with the submittals section. The submittal shall include a reduced set of drawings with the air outlets and equipment identified to correspond with the data sheets.

#### 3.4 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Operation and maintenance instructions shall be provided for heating and ventilating equipment as indicated in the general requirements section.

**END OF SECTION**

# **DIVISION 16**

## **ELECTRICAL**

## **SECTION 16000**

### **GENERAL PROVISIONS**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE**

- A. This section supplements all sections of this division and applies to all phases of work hereinafter specified and required to provide a complete installation of electrical systems.

##### **1.2 WORK INCLUDED**

- A. The Contractor is responsible for providing a complete and operating electrical system.
- B. The Contractor shall provide all labor, materials, and equipment as listed, shown, scheduled, or mentioned on the drawings and/or specified including all incidentals, operations, methods and skilled supervision required for a complete installation.

##### **1.3 COORDINATION OF WORK**

- A. Examine the drawings and specifications including the general, mechanical and work of other trades and coordinate all work so that it proceeds with a minimum of interference between trades.
- B. Check locations of lights, panelboards, equipment, piping, ducts, etc., to predetermine that all work clears openings, structural members, cabinets, ducts, piping, and other work or equipment having fixed locations.

##### **1.4 RESPONSIBILITY**

- A. The contractor is responsible for the installation of a complete piece of work in accordance with true intent of drawings and specifications.
- B. Consult all drawings of each contract to predetermine that the work and equipment will fit as planned.
- C. If, at any time, and in any case, change in location of lights, outlets, equipment, panels, etc., becomes necessary due to obstacles or installation of other trades as shown on any of the project drawings, such required changes shall be made by Contractor at no extra cost.

##### **1.5 CODES, FEES, PERMITS, AND REGULATIONS**

- A. Obtain and arrange for all permits, easements, licenses, and inspections required for work in this contract.
- B. All costs for required permits, easements, licenses, and inspections, are the responsibility of the Contractor and are to be included in his bid.

- C. Comply with the National Electrical Code, State of Montana Electrical Code, National Electrical Safety Code; and all local, county, state, and federal codes, regulations, and ordinances.

#### 1.6 INTENT OF DRAWINGS

- A. Drawings are partially diagrammatic, and do not necessarily show exact location of conduit, outlets, etc.
- B. Riser diagrams are schematic only, not to scale, and do not necessarily show physical arrangement of equipment.

#### 1.7 APPLICABLE DOCUMENTS

- A. Design, manufacture, testing, and method of installation of all apparatus and materials furnished shall conform to the latest applicable publications or standard rules referenced.
- B. Manufactured materials and equipment shall be installed and connected as directed by manufacturer unless noted otherwise herein or on the drawings.

#### 1.8 WORKMANSHIP

- A. Work under this contract shall be performed only by craftsmen skilled in the particular trades necessary to provide a complete installation.
- B. Install equipment in a neat and workmanlike manner, level and adjust for satisfactory operation. Install equipment so that all parts are easily accessible for inspection, operation, maintenance and repair. Align boxes vertically and horizontally to Engineer's satisfaction.
- C. All work, materials, and equipment are subject to inspection at any time by the A/E or his representative. The Engineer decides whether work is satisfactory. The Contractor shall replace materials or equipment not properly installed or finished, without any increase in payment received.

#### 1.9 MOUNTING HEIGHTS

- A. Work lines and established heights shall be in accordance with the drawings and specifications insofar as they extend. Verify all dimensions shown, and establish all elevations and detailed dimensions not shown. Maintain all code-required clearances around electrical equipment.
- B. Unless specifically noted otherwise, establish the exact location of electrical equipment based on the actual dimensions of equipment furnished.

#### 1.10 CUTTING, PATCHING, AND PAINTING

- A. See requirements in the General and Special Conditions.
- B. No cutting of structural members permitted without consent of Engineer in writing.



- C. Sleeves or conduit fittings through floors, walls or ceilings shall be flush with floors, walls, or ceilings and sized to accommodate the raceway.
- D. Where conduits penetrate waterproofed or fire-rated walls, floors, or ceilings, provide UL listed fittings and seals. Conduits penetrating the mechanical room floor slab where practical are to be grouped, provided with a concrete curb or housekeeping pad above the floor slab level and provided with waterproof seal fittings.
- E. All openings through floor slabs, masonry partitions or walls, and continuous partitions are to be caulked with non-flammable sealant to provide a water tight and airtight seal.
- F. Properly protect all apparatus, fixtures, appliances, material, equipment, and installation from damage of any kind. The A/E may reject any particular piece or pieces of material, apparatus, or equipment scratched, dented, or otherwise damaged. Where marring or disfigurements have occurred, replace or refinish the damaged surfaces to the satisfaction of the A/E. Painting must match adjoining color within a reasonable degree, or Contractor must repaint that portion until a close match is obtained. Materials used must be approved by A/E. Electrical contractor shall patch and repair all ceilings and walls he damages to the A/E's satisfaction.

#### 1.11 SUPPLEMENTARY FRAMING AND HOUSEKEEPING PADS

- A. Provide the design, fabrication, and erection of supplementary structural framing required for attachment of hangers or other devices supporting electrical equipment.
- B. Provide framing members of standard rolled A-36 steel shapes, designed for their actual loads with allowable stresses specified by AISC. Members shall be designed without excessive deflection and with consideration for rigidity under vibration, in accordance with standard structural practices.
- C. When suspending transformers or similar vibrating equipment, provide vibration isolators to isolate vibration from structural members.
- D. Provide housekeeping pads where shown on plans. Size as noted or shown. Electrical contractor shall hire general contractor to install pads. This also includes the pad for the main pad mounted transformer.

#### 1.12 SEALING AND RUST PREVENTION

- A. Seal equipment or components exposed to the weather and make watertight and insect-proof. Protect equipment outlets and conduit openings with temporary plugs or caps at all times.
- B. Provide hot dip galvanized components for all ferrous materials that are exposed to the weather.

#### 1.13 NOISE CONTROL

- A. All noise-producing devices similar to transformers, contactors, starters, etc., shall be mounted in such a manner as to effectively prevent the transmission of noise to an occupied space.

- B. Ballasts, transformers, contactors, starters, and similar equipment found to be noticeably noisier than other similar equipment on the project shall be replaced or repaired satisfactorily by the Contractor.

#### 1.14 EQUIPMENT NAMEPLATES

- A. Provide Micarta nameplates (screwed to equipment) 1-inch wide or more with 1/2-inch letters identifying panel designation or equipment served and voltage; e.g., Panel H1, 277/480 volt, 3 Phase-4 Wire. Provide nameplates as follows:
  - 1. Safety switches, starters, panel boards, feeder devices in MDP, and disconnect switches. Provide with black face and white letters.
  - 2. Main device in MDP shall be white face with red letters.
  - 3. Junction boxes and pull boxes over 100 square inches and all exposed junction or pull boxes shall be stenciled with black letters indicating system, voltage, and termination locations, e.g., Panel H1 Feeder, 277/480 volt, Switchboard to Panel H1.
- B. Plates for motor control devices in finished areas shall be engraved with name of devices controlled.

#### 1.15 MECHANICAL WORK AND EQUIPMENT

- A. Make electrical provisions and connect up power to all equipment. Refer to General Specifications and Division 15 Mechanical and the drawings for interlocking, sequence of operations, and other information for rough-in, wiring, and connection of equipment, and the responsibility for such control wiring.

#### 1.16 CLEANUP

- A. Upon completion of work, clean equipment of all dirt and debris, including light fixtures, lens, outlet boxes, interior spaces, etc. Clean site of all electrical scraps or debris.

#### 1.17 MATERIAL STORAGE AND DELIVERY

- A. Coordinate beforehand and provide for the handling and introduction of equipment into interior spaces of the building.
- B. Make provisions, which are acceptable to the Owner and Engineer, for delivery and storage of materials.

#### 1.18 TEMPORARY ELECTRICAL

- A. See Special Conditions and/or Division 1.

#### 1.19 TESTS

- A. Test all wiring and connections for shorts between conductors, shorts to ground, and for continuity prior to installation of fixtures and equipment.

- B. Perform an insulation resistance test on all feeder conductors installed under this contract, including neutrals, using a megohmmeter. Minimum value shall be 100 megohm at 60 degrees F.
- C. Correct and retest any defects and submit data.

#### 1.20 REMODELING WORK

- A. Wherever existing electrical wire, conduit, controls, circuits, etc., are cut, removed, or interrupted as a result of the remodeling; all such items that serve areas or equipment that remain shall be rerouted, extended, relocated, etc., as necessary to maintain operation of equipment and services.
- B. Downtime shall be held to a minimum, outages shall be scheduled at a time acceptable to and approved by the Owner. Consult with Owner in sufficient time for him to make necessary preparations for the outage.

#### 1.21 AS-BUILT DRAWINGS

- A. Maintain a separate set of electrical drawings at the job site at all times to be used as record drawings for the project. Show the location of all equipment or conduit installed other than as shown on the drawings. Indicate dimensions on all underground work referenced to established building lines.
- B. Deliver As-built drawings to the Engineer at the completion of the job. This set of drawings shall be kept neat and clean.

#### 1.22 BROCHURE OF EQUIPMENT

- A. Deliver to the Engineer at the completion of the job a brochure of equipment containing installation, maintenance, and operating instructions for each piece of equipment, parts lists, wiring diagrams, and one copy of each shop drawing and catalog cut submitted. File in one or more three-ring binders of sufficient number to hold everything. File in appropriate divider headings for each type of equipment.
- B. Provide a typewritten list in the front of the brochure which lists suppliers, with address and phone number, for each piece of equipment.
- C. Brochure must be submitted and approved before final payment will be authorized.

#### 1.23 SHOP DRAWINGS AND APPROVALS

- A. The materials, products and equipment described in the bidding documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution.
- B. No substitutions will be considered unless written request for approval has been submitted by the bidder and has been received by the engineer at least ten days prior to the original date for receipt of bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, original cuts (not Xerox), performance and test data and any other information necessary for an evaluation. An incomplete drawing will

not be reviewed. No correspondence will be returned. The burden of proof of the merit of the proposed substitute is upon the party proposing the substitution. The engineer's decision of approval or disapproval of the proposed substitution shall be final.

- C. If the engineer approves any proposed substitution, such approval will be set forth in an addendum. Bidders shall not rely upon approvals made in any other manner.
- D. Submittals shall be made as soon as possible after award of contract and prior to releasing equipment.
- E. Submit no later than 45 days after award of contract. If later than 45 days, submittals are still required, but all material shall be manufacturer as specified.
- F. Contractor shall check submittals for number of copies, adequate identification, correctness and compliance with drawings and specifications. Shop drawings will be revised, changed, and/or resubmitted until acceptable and approved by the Engineer.
- G. Approval of shop drawings and literature shall not relieve Contractor from responsibility for deviations from drawings or specifications, nor shall it relieve him from responsibility for errors in shop drawings or literature.
- H. Copies must be legible and submitted in six copies for distribution as follows: Engineer – 2, Contractor – 4.
- I. One copy of each approved shop drawing shall be retained by Contractor and bound in "Brochure of Equipment."
- J. Submittals for each item must be complete: All submittals must be marked to show items to be provided. Partial or incomplete submittals will be rejected.
  - 1. Circuit and load schedule charts for each panel for approval prior to construction:
  - 2. Wiring Devices:
  - 3. Catalog cuts for all devices and plates:
  - 4. Fuses:
  - 5. Catalog cuts with sizes marked for which item, time-current curves for main, feeder and motor protective fuses.
  - 6. Main Distribution Panel:
  - 7. Shop drawings showing bus layout, breaker and/or fusible switch layout, bus size, lug size, voltage, phase, physical dimensions, and conduit entrance locations. Catalog cuts for OCPD's including frame or amp size, lug sizes, and device catalog numbers.
  - 8. Panelboards:
  - 9. Shop drawings showing breaker and/or fusible switch layout, size, voltage, phase, and physical dimensions. Catalog cuts for overcurrent protective devices.
  - 10. Safety Switches:
  - 11. Shop drawings, showing electrical and physical sizes and characteristics, item each switch is to be used for, and catalog number.
  - 12. Motor Starters:
  - 13. Shop drawings showing electrical and physical sizes and characteristics, item each starter is to be used for, catalog number, accessories and options provided, replacement pilot light type and number.
  - 14. Control Systems:
  - 15. Catalog cuts showing all pieces of equipment and catalog number with descriptive literature. Submit wiring diagram showing physical arrangement of

devices with conduit runs shown and number and type of conductors to each device.

16. Miscellaneous Items:
17. Shop drawings and/or catalog cuts with same basic information as items previously listed for any major items or pieces of equipment. Items such as transformers, contactors, relays, etc.

#### 1.24 GUARANTEE/WARRANTY

- A. The Contractor shall warrant and guarantee all work done under Division 16 to be free from defects in material or workmanship- for a period of one year from the date of Final Acceptance of the Work. During the warranty period the Contractor will, at his own expense, repair and replace all defective materials and work, and all other work damaged as a result.

**END OF SECTION**

## **SECTION 16110**

### **RACEWAYS AND FITTINGS**

#### **PART 1 - PRODUCTS**

##### **1.1 GENERAL**

- A. Rigid Steel Conduit (RGS): Conduit shall be hot-dipped, galvanized, zinc-coated with hot-dipped, galvanized threaded couplings and connectors. Conduit bushings shall be insulated. Grounding bushings shall be insulated with pressure type lugs.
- B. Intermediate Grade Rigid Conduit (IMC): Conduit shall be galvanized zinc-coated with galvanized threaded couplings and connectors.
- C. Flexible Liquid-Tight Metal Conduit: Conduit shall be zinc-coated, single-strip steel armor type with a PVC covering. Flexible liquid-tight metal conduit shall have rain-tight steel fittings.
- D. Rigid PVC Conduit: Conduit shall be heavy-wall schedule 80 polyvinyl chloride conduit. Conduit shall conform to all provisions of the code and shall be UL listed for underground use and rated for 90 degrees C conductors. Fittings shall be as recommended by the manufacturer. Schedule 40 PVC conduit is not acceptable and shall not be used.

#### **PART 2 - EXECUTION**

##### **2.1 GENERAL**

- A. Install all conductors in conduit. Conduit may be run exposed in pump rooms, or similar mechanical spaces. All exposed conduits shall be run parallel or perpendicular to building construction.
- B. Raceways in masonry walls, outdoors, exposed to weather, or subject to damage shall be RGS.
- C. Raceways in interior partitions or exposed in interior spaces where not subject to damage shall be RGS or IMC.
- D. Raceways in concrete, under concrete slabs, or underground shall be RGS or schedule 80 PVC, unless noted otherwise.
- E. PVC is in no case allowed exposed above grade, or inside buildings or vaults. The only location where PVC is allowed is underground – NO EXCEPTIONS.
- F. PVC coated RGS elbows shall always be used where elbows are required in PVC conduit runs. This includes where the raceway is turned up to go through a concrete slab.

- G. Install ground wire in all conduits.
- H. Secondary feed conduits from the service transformer to the Main Distribution Panel in the building shall be RGS.
- I. All underground RGS conduit shall be PVC coated or asphalt coated. This includes conduit installed below slabs.
- J. Final connections to all motors; transformers; equipment subject to vibration; and equipment in wet, damp, or outdoor locations shall be made with liquid-tight, flexible metal conduit with a ground wire.
  - 1. Continuity: Provide metallic conduit continuous between outlets, enclosures, and boxes. Secure conduit to all boxes and enclosures to provide electrical continuity. Provide approved fitting and bushing on terminals of metallic conduits.
- K. Size: Provide conduit sizes in accordance with code for the size, type, and quantity of conductors installed unless larger conduit is indicated. Allow for internal ground wires in all conduits. All conduit and conductor sizes shown are based upon copper conductors with THW insulation. Hashmarks are not shown on plans for ground conductors. Ground wires are to be included in addition to the number of conductors indicated by the hashmarks.
- L. Raceways Embedded in Concrete: Provide O.Z. type ZX, DX, or DXX expansion fittings on all conduits crossing expansion joints. Do not displace reinforcing steel to accommodate conduit or boxes. Do not install conduit directly under slabs resting on ground. Conduit in slabs shall be encased with 1 inch or more concrete and outside diameter shall not exceed one-third of slab thickness. Conduit installed under slabs shall have 6 inches or more compacted fill between conduit and slab.
- M. Raceways Exposed: Run exposed raceways in straight lines; at right angles; or paralleled with walls, beams or columns.
- N. Raceways Through Roof: Where raceways penetrate the roof seal, provide suitable pitch pockets or lead flashing and counter flashing.
- O. Supports: Support raceways by straps, suitable clamps, or hangers to provide a rigid installation. Do not support conduit from other pipe, or in a manner to prevent the ready removal of other pipe. Conduit supports shall be on intervals of 8 feet or closer as required for proper support and within 3 feet of boxes or fittings, or closer if required by code.
- P. Joints and Connections: Make watertight all couplings and connections in threaded conduit. Cut all joints square, ream smooth, and properly thread. All connections are to be made with approved connectors. All box connections shall have a plastic bushing. Where double locknuts are used, provide one inside and one outside of the enclosure.
- Q. Protection: Cap raceways stubbed up immediately upon their installation with Ideal Conduloc spacer/cap fittings or O.Z. Push-Pull tab caps.

- R. Expansion Joints: Provide bonding jumpers for conduit crossing expansion joints. Where differential settlement may occur, use deflection fitting. Provide expansion fittings in raceways in accordance with manufacturer's recommendations.
- S. Underground Conduits: Do not install conduit under or near structural footings unless approved by Engineer. Install raceways not less than 18 inches below finished grade unless encased in 2 inches or of more concrete. In areas of vehicular traffic, minimum depth shall be 24 inches.
- T. Bends:
1. Radius: Bends in conduit shall conform to code requirements.
  2. Number in Runs: Conduit shall not be installed with bends exceeding four of 90 degrees or its equivalent, 360 degrees total between pull boxes and/or fittings.
  3. How Made: Bends shall be made so as not to injure the conduit or effectively decrease its internal diameter. Bends in conduit of 1¼" or larger shall be made with manufactured mechanical benders, or factory-made ells shall be utilized. Heat shall not be applied.
- U. Empty Conduit: Provide nonmetallic pull wire with a tensile strength of 200 lbs. or more in every empty conduit.
- V. Excavating and Trenching: Excavation and trenches for underground systems shall be excavated at least 4" below required depth. Fill bottom of trench with clean, crushed gravel or sand. After installation, fill side voids and up 4" over conduit with clean, crushed gravel or sand. Install buried warning tape above buried conduit. Compact soil of backfill to original density to avoid settling of trench.

#### **END OF SECTION**



## SECTION 16120

### CONDUCTORS

#### PART 1 - PRODUCTS

##### 1.1 CONDUCTOR TYPE

- A. All Conductors: Conductors shall conform to UL, Fed. Spec. J-C30, and IPCEA as applicable. Provide recently manufactured cable with guarantees and warranties initiated during the contract period.
- B. Insulation: Provide conductors with insulation rated for 600 volts. Insulation type THW, XHHW, or THWN with minimum temperature rating of 75 C wet or dry. Type THHN may be used in dry, above grade locations only.
- C. Solid Conductors: Conductors No. 10 and smaller shall be solid copper.
- D. Stranded Conductors: Conductors No. 8 and larger shall be stranded copper.
- E. Conductors in Light Fixtures: Provide type THHN conductors, 90 degrees C dry for branch circuit conductors in fixtures UL approved for end-to-end assembly and for connection to recessed or surface-mounted fixtures. Conform with code for fixture wiring and for wet or dry locations.
- F. Twisted Shielded Pairs, Signal and Communication Conductors.
  - 1. 16 AWG stranded (9x30) tinned copper conductors, twisted pair, FEP insulation, overall 100% shield, 20 AWG stranded tinned copper drain wire, FEP jacket.
  - 2. FEP Teflon jacket for water resistance.
  - 3. One pair, #16 AWG, 9x30 stranding, tinned copper.
  - 4. FEP – Fluorinated Ethylene Propylene insulation, 0.007 inches
  - 5. Six (6) twists/ foot, 2.0 inch pair lay length.
  - 6. 100% Beldfoil aluminum foil tape shield.
  - 7. 20 AWG shield drain wire.
  - 8. Outer Jacket: FEP Teflon, 0.014 inches.
  - 9. Outside diameter: 0.15 inches.
  - 10. NEC CMP rated.
  - 11. Water and oil resistant
  - 12. Plenum rated
  - 13. Maximum voltage: 300 V RMS
- G. Signaling and Communication Conductors: Provide as specified in appropriate section.
- H. Aluminum Conductors: Aluminum is not acceptable. Conductors shall be copper unless specifically noted otherwise.
- I. Conductor Size: Provide No. 12 AWG copper wire or larger for lighting and power. Provide No. 14 AWG copper or larger for control circuits unless otherwise specified or required. Provide conductors of an ampacity equal to or greater than the over-current

protective device rating. No more than one homerun (three phase conductors, one neutral, and one ground conductor) shall be installed in any conduit run, unless specifically shown on the plans. If more than one homerun is shown in a conduit run, the conductors shall be derated and increased in size as required by the NEC. Do not parallel conductors smaller than No. 1/0 AWG.

- J. Exterior Feeders: Provide type THW conductors for service entrance conductors and exterior lighting and power circuits.

## 1.2 EXECUTION

- A. Conductor Installation: Install conductors in conduit sized in accordance with code. Install all conductors in a raceway at one time, insuring that conductors do not cross one another or kink while being pulled. Lubricants for wire pulling shall conform to UL requirements for the insulation and raceway material.
- B. Conductor Installation: Homerun circuits to panels shall be limited to a maximum of three circuits for three phase systems, and two circuits for single phase systems. For example, a homerun to a three phase panel shall be limited to three phase conductors (separate phases), one neutral, and one equipment grounding conductor. There shall be no exceptions.
- C. Splices, Taps, Terminations:
  - 1. No splices are permitted in either service or feeder conductors. No splices or taps are permitted in branch circuits except at outlets or accessible junction boxes.
  - 2. Splices and taps for conductors No. 8 and larger shall be insulated using Thomas and Betts heat shrink insulated sleeves with sealant, heat shrink insulated boots with sealant, or preformed H-tap insulating covers.
  - 3. Splices and taps for conductors No. 10 and smaller shall be made with pre-insulated connectors 3M "Scotchlock" or Ideal "Wing Nut."
  - 4. Provide solderless lugs or forked and flanged connectors for all power and control conductors that terminate on equipment or terminal strips.

**END OF SECTION**

## **SECTION 16130**

### **BOXES**

#### **PART 1 - PRODUCTS**

##### **1.1 BOXES (FS OR FD)**

- A. Boxes used with RGS or IMC conduit (surface mounted or exposed) shall be Crouse-Hinds type FS or FD cast iron alloy. Hubs are to be threaded. Provide with cast cover and neoprene gasket.

##### **1.2 BOXES (MASONRY)**

- A. Where conduit is recessed in masonry walls, use masonry type boxes recessed flush in the wall. Raised device cover depth to be selected such that the block can be easily cut for a snug fit to raised cover sides.

##### **1.3 PULL BOXES**

- A. Pull boxes shall be similar to the boxes listed above, for the conduit types listed. Boxes shall be sized per code or as shown. Provide removable cover on the largest access side of the box.

##### **1.4 BOX SIZE**

- A. Minimum box size shall be as required by the NEC

##### **1.5 PULL-BOXES**

- A. Underground: Boxes installed underground shall be either pre-cast concrete, cast iron, "Quazite" composite, or as detailed on the drawings. Minimum size to be 12" x 24" x 18" deep, or larger as required by NEC. Provide locking cover with ELECTRIC logo.

##### **1.6 MOUNTING HEIGHTS (FROM FINISHED FLOOR TO CENTER OF OUTLET)**

- A. General wall switches – 4'0" unless otherwise noted.
- B. Convenience outlets in Industrial spaces – 48"
- C. Special system devices – as required and/or as noted on drawings.

## 1.7 EXECUTION

- A. Coordinate installation with other trades.
- B. All junction and pull boxes must be accessible as required by code. Where junction boxes are installed in inaccessible locations, the electrical contractor shall provide and install access doors.
- C. Rigidly mount all boxes; make sure they are straight, level, plumb, and flush with finished surfaces. Use box extensions where box is set too deep. Plug open holes in boxes with suitable blanking devices.
- D. Boxes for special systems – as required and/or as noted on drawings.
- E. Where exposed in finished spaces, junction boxes shall have blank covers matching switch plates.
- F. Install pull boxes in locations that will be accessible after completion of the building or project. Provide pull boxes or junction boxes to limit conduit runs to 200 feet and to limit angles to the equivalent of 360 degrees. Additional pull boxes may be provided to facilitate wire pulling.

**END OF SECTION**

## SECTION 16140

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.1 PRODUCTS

- A. Line Voltage Wiring Devices: Provide wiring devices indicated. Bryant devices are specified to established minimum quality and general requirements. Comparable devices manufactured by Leviton, G.E., Arrow Hart, Pass & Seymore, or Hubbell may be provided. All similar devices shall be of one manufacturer.
1. Switches: Provide specification grade heavy-duty flush tumbler switches. Color to be ivory. Switches shall be 120/277V, 20 amp rated. Inductive load rating shall be a full 20 amps. Switches shall be side- or back-wired, quiet action type.
  2. Single Pole Single Throw 4901-I
    - a. Momentary contact switches shall be 20 amp, two-circuit, three-position center off, single pole double throw 4921-I.
    - b. Where switch with pilot light is shown, provide 4901-PLR120 switch with 120V or 277V pilot light. "Switch on – Light On".
  3. Receptacles: Provide specification grade, heavy-duty, self-grounding type, ivory, for side- and back-wiring.
    - a. Duplex 20 amp, 125 volt, Nema 5-20R 5362-I
    - b. Duplex 20 amp, 125 volt, GFI GFR53FT-IEach receptacle shown to have GFI protection shall be a separate GFI device. Feed through protection from an upstream device is not an acceptable means of providing GF protection.
  4. Plates for Line Voltage Devices:
    - a. Cast device covers used with type FS or FD boxes are to be Crouse-Hinds type DS. For indoor, non-WP applications.
    - b. Weatherproof receptacle covers used with type FS or FD boxes are to be Crouse-Hinds type WLRS or WLRD.
    - c. Weatherproof switch covers used with type FS or FD boxes are to be Crouse-Hinds type DS181.

##### 1.2 EXECUTION

- A. Wiring Devices
1. Install all wiring devices indicated, complete with cover plate.
  2. Outlets installed on circuits supplying more than one device to be connected with a pigtail and "Scotchlock" connector to neutral so that removal of outlet will not disrupt continuity for branch circuit neutral. A like connection to be made to the equipment ground wire
  3. Provide plates plumb and flush against the wall.
  4. Contractor is responsible for pulling separate neutrals for GFI breakers whether or not the separate neutrals are shown on plans.

B. Special Outlets

1. Install and wire special outlets where indicated. Provide plates for all devices.  
Verify all special outlet locations and device configurations prior to installation.

**END OF SECTION**

## SECTION 16150

### MOTOR CONTROL DEVICES

#### PART 1 - PRODUCTS

##### 1.1 GENERAL

- A. Motors: Equipment with factory mounted motors shall be set in place by the trade furnishing the equipment and motors.
- B. Motor Controls: Provide power wiring, motor connections, disconnects, starters with accessories, and support required for the safe and satisfactory control of all motors as required by code.

##### 1.2 MOTOR STARTERS

- A. Square D starters are specified to establish quality and general requirements. Comparable starters manufactured by Siemens or General Electric may be provided. Provide magnetic starters for all three-phase motors except as indicated otherwise. Provide manual starters for all single-phase motors except as indicated otherwise. Provide starters in individual enclosure or combination type with disconnect devices, as indicated. Enclosures in interior spaces are to be NEMA 1. Enclosures outside are to be NEMA 3R rain-tight.
  - 1. Manual Starters
    - 1) Provide toggle type starter with thermal overload protection and red pilot light, class 2510, single-speed. Provide with Hand-Auto switch where indicated.
  - a. Magnetic Starters
    - a. Provide Class 8536 full-voltage non-reversing magnetic starters with the following:
      - i. Thermal overload protection sized to motor amps.
      - ii. Red "on" pilot light.
      - iii. 120 volt coils.
      - iv. Fused control circuit, with disconnect switch, fed from integral control transformer.
      - v. Minimum of two aux N.O. contacts, and two aux N.C. contacts, field convertible, or as scheduled.
      - vi. HOA switch except where indicated otherwise.
      - vii. Manual reset button.
      - viii. Combo units to be Circuit Breaker type, Class 8539

## **PART 2 - EXECUTION**

### **2.1 GENERAL**

- A. Provide starters and control centers where shown.

### **2.2 COORDINATION**

- A. Coordinate with the mechanical installation all details pertaining to the motor control equipment, including but not limited to, motor size, starter coil voltage ratings, mechanical control device voltage and amp ratings, and control devices such as momentary contact vs. maintained contact.

### **2.3 CONTROL WIRING**

- A. Provide starter interlocking wiring as indicated. Provide terminals for connection of all wires.
- B. Provide electrical relays, interlocks, devices, and wiring not furnished by Mechanical Contractor, for systems to function as described.

### **2.4 PUMP PROTECTION SYSTEM**

- A. The motor control shall be compatible with the Franklin Electric Subtrol-Plus protection system. See Section 11210 SUBMERSIBLE TURBINE PUMPS for specifications on the Subtrol-Plus protection system.

**END OF SECTION**



## **SECTION 16170**

### **FUSES**

#### **PART 1 - GENERAL**

##### **1.1 PRODUCTS**

###### **A. General**

1. Provide fuses at all locations shown on the drawings and as required for supplemental protection.
2. Buss fuses are specified. All main, feeder, and motor fuses shall be as specified. Shop drawings shall include fuse types, sizes, and where used, provide time-current characteristics for all fuses to be provided.

###### **B. Fuses**

1. Main and Feeder Protection: For protective devices 601 amps and greater at all voltages below 600 volts, provide UL Class L fuses, Type KRP-C Hi Cap, current limited. For protective devices 600 amps and below at all voltages below 250 volts, provide UL Class RK-1 rejection fuses, Type LPN-RK, low peak dual element, or Type LPS-RK over 240 volt. All main and feeder fuses to have 200,000 amp interrupting capacity symmetrical.
2. Fuse Label: Provide instruction labels for all fuses installed, indicating type, size, voltage, and description.
3. Fuse Clips: Where NEC class fuses are installed, fuse blocks and clips shall be designed to only accept fuses of the particular size and type specified. Fuse clips shall reject improper fuses.

##### **1.2 EXECUTION**

###### **A. Spare Fuses (HIGH VOLTAGE AND LOW VOLTAGE)**

1. Furnish spare fuses of quantity equal to 20 percent of the number of each size installed, but not fewer than three of each size.

###### **B. Motor Protections**

1. Where fuses feeding motors are indicated but not sized, coordinate the fuse size with the motor installed using Bussmans Motor Protection guide.

###### **C. Fuse Label**

1. Mount fuse labels permanently on the device enclosures.

**END OF SECTION**

## **SECTION 16430**

### **ELECTRICAL SERVICE**

#### **PART 1 - GENERAL**

##### **1.1 PRODUCTS**

- A. General
  - 1. The electrical service to the Pump House shall be as shown on the Electrical One-Line Diagram.
- B. Utility Company Costs for Construction
  - 1. All Costs from the Electrical Utility for construction of the new service shall be billed direct to the Owner, do not include these costs in the bid price.
- C. Grounding
  - 1. Provide ground rods, service grounds, and copper conductors
- D. Secondary Service
  - 1. Provide the secondary service to the Pump House as shown on the Electrical One-Line diagram. The service voltage will be as indicated on the plans.

##### **1.2 EXECUTION**

- A. General
  - 1. All work shall be in accordance with the power company's requirements and standards, and subject to their approval. Carefully coordinate the installation of service entrance equipment, and all details related to the new service, with the electric utility prior to the beginning of construction.

**END OF SECTION**

## SECTION 16450

### GROUNDING SYSTEM

#### PART 1 - GENERAL

##### 1.1 PRODUCTS

- A. Provide all conductors, ground rods, raceways, grounding busses, lugs, jumpers, clamps, and other required devices for the grounding system.

##### 1.2 EXECUTION

- A. General
  - 1. Ground all electrical systems completely and effectively as required by code and as specified. Provide all ground systems and make connections mechanically secure and electrically continuous.
- B. Service Entrance Ground
  - 1. Connect the incoming electrical service neutral conductor(s) to the neutral bus in the main distribution panel. Connect the main distribution panel neutral bus to the main distribution panel ground bus, and ground the main distribution panel ground bus to the building ground electrode. Building ground electrode shall consist of grounding as required by Section 250-81 of the National Electrical Code whether shown on plans or not shown on plans.
  - 2. Clean the contact surfaces at all ground connections.
- C. Raceways Systems
  - 1. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings, and equipment. At the point of electrical service entrance, bond all metallic raceways together, with a ground conductor, and connect to the system ground bus. Bond all boxes as specified for equipment.
  - 2. A separate green equipment-grounding conductor shall be installed in every raceway, including all metallic raceways. Continuity of metallic raceways shall not be solely relied upon for grounding. A separate equipment-grounding conductor shall be installed in every raceway.
- D. Equipment
  - 1. Provide separate green wire equipment ground conductor in all nonmetallic electrical raceways and metallic raceways to effectively ground equipment and enclosures. Green wire equipment ground conductor shall be connected at all intermediate enclosures, boxes, equipment, fixtures, etc. Provide all required bonding jumpers, grounding bushings, lugs, busses, etc. Connect equipment grounds to the metallic raceway system. Use the same size equipment ground conductors as phase conductors, up through No. 10 AWG. Use NEC for conductor size with phase conductors No. 8 and larger if not shown.
- E. Receptacles
  - 1. Provide separate green wire ground conductor to all receptacles.

2. Connect the ground terminal on each receptacle to the independent continuous insulated ground conductor where provided with pigtail and “Scotchlock” so that removal of receptacle will not disrupt ground continuity.
- F. Motors
1. All motor connections shall have an internal insulated ground conductor in all conduits.
  2. Connect the ground conductor to the metal frame with a bolted solderless lug. Bolts, screws, and washers shall be bronze.
- G. Ground Bushings
1. Install ground bushings with a wire to ground bus on any conduits that are 1¼” or larger.

**END OF SECTION**

## **SECTION 16460**

### **DRY TYPE TRANSFORMERS**

#### **PART 1 - GENERAL**

##### **1.1 PRODUCTS**

- A. Transformers
  - 1. Transformers shall be Square D Sorgel dry type, totally enclosed and ventilated, 80 deg C. rise insulation, and with maximum sound levels of 45 DB through 150 KVA and 50 DB through 300 KVA.
  - 2. Equivalent products of Siemens and GE are acceptable.
  - 3. Size, type, style, ratings, and connection as noted on drawings.

##### **1.2 EXECUTION**

- A. Install at locations noted in strict accord with manufacturer's recommendations. All units shall be mounted using vibration insulators. Use suspension rods, wall brackets, or floor supports as required. Isolate from structure in all cases.
- B. Make all connections using flexible conduit at transformer, minimum length of 18".
- C. Install a minimum of 6" away from any wall, or further if recommended by manufacturer.
- D. Run ground wire through flexible conduit to maintain positive ground continuity with conduit ground.
- E. Any noisy units shall have the installation revised to achieve an acceptable sound level or replace with a new unit with an acceptable sound level.
- F. Ground all transformers as required by Section 250-81 of the National Electrical Code whether shown on plans or not shown on plans.

**END OF SECTION**

## SECTION 16470

### PANELBOARDS AND DISTRIBUTION GEAR

#### A. PRODUCTS

1. General
  - a. Square D equipment is specified to establish minimum quality and general requirements. Comparable equipment manufactured by Siemens or General Electric may be provided.
2. Branch Circuit Panels - Provide Type NEHB or NQOD panel boards as required with bolt-on breakers with interrupting capacity as shown on the panel schedules. Box dimensions to be nominally 22" wide by 5 ¾" deep. Provide ground bus in each panel. Panel bussing shall be copper.
  - a. Cabinets: Provide zinc-coated, zinc-steel cabinets conforming to UL requirements, bearing UL inspection label. Provide primer coat and finish coat of manufacturer's standard color on all cabinet surfaces, trim, and doors. Provide NEMA 1 enclosure unless otherwise specified. Provide doors with concealed trim clamps, flush lock, and master keyed. Provide two keys for each panel board. Mount a directory holder with clear plastic cover and metal frame on the inside of each door. Install a typewritten directory, properly identifying each circuit and the specific load served.
  - b. Circuit Breakers:
    - (1) Provide factory-installed, molded case circuit breakers conforming to Fed. Spec. WC-3758 and the following:
      - (a) Thermal magnetic trip units, trip-free, trip-indicating.
      - (b) Quick-make, quick-break contacts with interrupting capacity equal to or greater than indicated.
      - (c) Common internal trip for all 2- or 3- pole breakers.
      - (d) Panels and circuit breakers shall be fully rated for the AIC value indicated. Series rated systems or breakers are not permitted.
    - (2) Special Features: Provide subfeed lugs, shunttrip, or any specialty called out on plans or schedules. Tandem or half-sized circuit breakers are not permitted.
3. Main Distribution Boards
  - a. The main distribution boards shall be Square D I-line with interrupting capacity as shown on the panel schedules. Bussing shall be copper. Box dimensions to be nominally 32" wide by 8¼" deep minimum. Provide ground bus in panel. Breakers shall be bolt-on type with same characteristics as listed under branch circuit panels. Breakers and system shall be fully rated for the AIC values shown, series rated systems are not permitted. Breakers as shown in panel schedules must be mounted opposite each other and side by side as shown. Numbering and layout must be per plans.
4. Safety Switches
  - a. Provide disconnects as noted. Disconnect switches for 120 volt motors or equipment shall be toggle type manual motor starters with overload protection in NEMA 1 enclosure or as required or called out on plans.
  - b. Disconnect switches for two-pole and three-pole loads shall be Square D heavy-duty type in NEMA 1 enclosure, fused type, voltage rating as required.
  - c. All disconnect switches installed exterior to the building to be installed in NEMA 3R enclosures, or as called out on plans.

B. EXECUTION

1. Support
  - a. Properly align distribution boards, panel boards, and safety switches and adequately support independent of the connecting raceways. Provide all steel shapes and appurtenance necessary for the support of the equipment.
2. Protection
  - a. Where distribution boards, panel boards, or disconnects are installed during construction, place temporary covers over the openings or enclosure at all times.
3. Conductor Terminations
  - a. Coordinate lug types and sizes and wiring space with termination requirements of conductors to be provided.
4. Circuit Numbering
  - a. All circuits shall be run and numbered to agree with drawings. All panel layouts shall match drawings.
5. Conductor Installation.
  - a. In no case shall circuits from one panel be routed through the cabinet of another panel. The intent is to prevent one panel from being used as a raceway for circuits from a different panel. There shall be no exceptions.
6. Ground Bushings
  - a. Install ground bushings on all conduits entering main switchboard and tie to ground bus.
7. Testing
  - a. Any tests required by local or state officials shall be performed by a factory representative of the equipment and all associated costs borne by the electrical contractor.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 PROJECT DESCRIPTION**

#### **A. Description of Work**

The work to be accomplished under this section shall consist of furnishing the equipment necessary for a complete automatic control and monitoring system to function as specified herein and as shown on the drawings. The system integrator shall furnish a completely integrated all solid-state radio telemetry base Supervisory Control and Data Acquisition (SCADA) system. It shall be the system integrator's responsibility to supply a system that is compatible with existing equipment, new equipment supplied by others as part of this contract, and equipment supplied in other contracts. The complete system shall be designed, fabricated, programmed, tested, started up, and warranted by a single supplier to insure a single source of responsibility.

#### **B. Scope of Work**

This section covers a radio telemetry based SCADA and Instrumentation System to include:

- (1) Water Tank Remote Unit,
- (1) Visitor Center Remote Unit,
- (1) Pump Station Remote Unit/Central Terminal Unit with
- (1) Operator Display Console - ODC (Industrial Front Panel Computer System).

Provide a SCADA System to continuously monitor and maintain the water level in the storage tank, monitor the water level in the lower cistern, and control the operation of the (2) supply pumps and the (2) booster pumps. The system shall provide status/alarm indications and dialup alarm service. The pumps shall be controlled from the Central Telemetry Unit (CTU) that will be located at the new pump house panel. The pump operation shall be such that, at the storage tank low level set point, one supply pump starts, then one booster pump starts after an adjustable time delay of 0 to 10 minutes. Each pump will be allowed to alternate between cycles. Pump control set points will be adjustable at the new pump house panel. All monitored points/data shall be displayed graphically in the front panel mounted ODC - Industrial Touchscreen Computer System. All setpoint controls shall be operator selectable. Tank and chemical level trending, pump runtime reporting, event/alarm logging, and historical data collection shall be standard functions of the ODC software. The ODC software shall include a software phone dialer for dialing operators in the event of an alarm. A schematic of the system is shown on Figure 1 attached to the end of this specification.

The SCADA system shall utilize a VHF or UHF radio data network linking all three sites together.

The Storage Tank RTU shall include (1) pressure transducer for monitoring the tank level.

The Visitor Center shall include a LCD Keypad displaying the storage tank water level.

The Pump House shall include (1) pressure transducer for monitoring the Lower Cistern water level, (1) pressure transducer for monitoring the discharge pressure, and relay interface for controlling the (2) cistern pumps and (2) booster pumps.

Under normal operation the (4) pumps will be controlled by the amount of water in the Storage Tank. In the event the Storage Tank Level cannot be displayed at the pump house (CTU) the



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SCADA system shall automatically control the pumps based off the discharge pressure transducer.

The CTU shall be connected to the motor control center and shall immediately shut off the pumps in the event the low cistern level alarm is initiated.

The CTU shall be connected to the UV system allowing alarm for set point low transmittance conditions. The pumps shall be shut off in the event that a low transmittance is initiated.

### C. General/Electrical Contractor Shall Supply

1. All equipment required in other sections of the specifications.
2. All labor for installation of the system.

### D. System Integrator Shall Supply:

1. Engineering submittal and shop drawings prior to installation.
2. All the paper work and fees necessary to obtain a FCC radio license in the name of the Owner.
3. All user licenses and fees for software supplied in this system with licenses in the name of the owner.
4. Spare parts and maintenance tools, as detailed in this section.
5. Operation and maintenance manuals, as detailed in this section.
6. All start-up labor and services, as required for equipment specified in this section.
7. Operator training as detailed in this section.

## 1.2 QUALITY ASSURANCE

### A. Manufacturer's Qualifications

The system specified herein shall be the product of a manufacturer who can demonstrate at least five (5) years of satisfactory experience in furnishing and installing comparable radio based telemetry/control systems for water and wastewater installations. The manufacturer of this system shall maintain a 24-hour available inventory of all replaceable modules to assure the Owner of prompt maintenance service and a single source of responsibility. The manufacturer shall certify this to the Engineer in writing at the time of bidder pre-qualification.

### B. Approved SCADA Suppliers

The SCADA system described in this specification is a system as manufactured by Micro-Comm, Inc., of Olathe KS, Siemens Water Technologies /Control Systems of Vadnais Heights, MN, or Industrial Automation Consulting, Three Forks, MT. The naming of manufacturers in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering specified (or equal) equipment. Rather, the intent is to establish a standard for material used and define the system operational design.

Other integrators desiring to bid this project as "alternate" integrators must seek pre-bid approval during the submittal process. The Consulting Engineer and the Owner shall be the sole judge as to whether the alternate equipment is considered an approved equal. Approval of an alternate system by the Engineer will not relieve the alternate system of strict adherence to these specifications. The pre-bid submittal shall include the following:

1. An installation list with the names and phone numbers of both the Owner and Consulting Engineer for at least five projects of similar size and complexity.

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2. A "statement of compliance" detailing paragraph by paragraph the bidders compliance to these specifications.
3. Block diagrams for the various sites in the proposed system showing the selected pieces of hardware equipment to be used.
4. Sample electrical drawings for typical sites proposed in this contract.
5. A product performance data sheet shall be included for each hardware component in the system (i.e. antennas, radios, coaxial cables & arrestors, programmable controllers, power supplies, time delays and relays, and the various sensors required) and each software component (programming & configuration software and operator display console software).
6. Radio path study for each radio path in the system. Bidders shall satisfy themselves that the necessary radio frequency(s) can be obtained. The radio path study provided by each bidder shall utilize either:
  - a. Computer generated techniques utilizing a USGS 3 second terrain database to plot the path profiles for each radio path with elevation samples at not more than 200 foot increments.
  - b. Actual field measurements to showing the necessary antenna heights, transmitter power, and antenna gains required to insure a 20db fade margin as detailed in Section 2.02 of these specifications. The a physical path analysis shall be made using temporary equipment installations and a radio communications analyzer to measure actual path margins. The bidder shall include in his bid, all the calculations used to extrapolate the measured data. The bidder is expected to obtain the necessary temporary FCC license for the study.
7. Communications diagram for the entire system showing normal CTU-RTU communications paths and Peer-to-Peer back-up communications paths.

C. Approval Agencies

The control system and its components shall comply with all applicable requirements of the following:

1. Electrical Code Compliance (National & Local)
2. UL 508A
3. NEMA Compliance
4. IEEE Compliance
5. EIA Compliance
6. FCC Compliance

**1.3 SUBMITTALS:**

- A. Complete submittal shall be provided to the engineer for approval prior to equipment fabrication. The submittal data shall include the following:
  1. Product Data - Provide product data sheets for each instrument and component supplied in the system. The data sheets shall show the component name as used on reference drawings, manufacturer's model number or other product designator, input and output characteristics, scale or ranges selected, electrical or mechanical requirements, and materials compatibility.
  2. Shop Drawings - Provide drawings for each panel showing the wiring diagrams for control circuits and interconnections of all components. The drawings shall include wiring diagrams for all remote devices connected to the panel.
  3. Panel Layout Drawings - A front panel and sub-panel layout shall be included as part of each control panel drawing. Components shall be clearly labeled on the drawing.
  4. Installation Drawings - Typical installation drawings applicable to each site in the system shall be included.

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5. Operator Interface Software - The submittal shall include a generic but detailed technical description of the Operator's Interface Software as proposed for this system including:
  - a. Sample text screens and menus
  - b. Sample graphics screens
  - c. Sample report logs and printed graphs

**1.4 MAINTENANCE INFORMATION**

A. Maintenance Data Manuals

Submit maintenance manuals and "as built" drawings on all items supplied with the system. The manuals and drawings are to be bound into one or more books as needed. In addition to "as built" engineering submittal data and drawings, the manual shall include trouble shooting guides and maintenance and calibration data for all adjustable items.

**1.5 JOB CONDITIONS**

- A. All instruments and equipment shall be designed to operate under the environmental conditions where they are to perform their service. The equipment shall be designed to handle lightning and transient voltages as normal environmental hazards. The environmental conditions are as follows:

1. Outdoor - The equipment will be exposed to direct sunlight, dust, rain, snow, ambient temperatures from -20 to +120 degrees F, relative humidity of 10 to 100 percent, and other natural outdoor conditions. The installations shall be hardened to withstand normal vandalism.
2. Indoor - The equipment will be capable of operating in ambient temperatures of +32 to +130 degrees F and relative humidity of 20 to 100 percent.

**1.6 DELIVERY, STORAGE, & HANDLING**

- A. All items shall be stored in a dry sheltered place, not exposed to the outside elements, until ready for installation. All items shall be handled with appropriate care to avoid damage during transport and installation.

**1.7 SEQUENCING & SCHEDULING**

A. Coordination

The Systems Integrator shall coordinate with other electrical and mechanical work including wires/cables, raceways, electrical boxes and fittings, controls supplied by others, and existing controls, to properly interface installation and commissioning of the control system.

B. Sequence

Sequence installation and start-up work with other trades to minimize downtime and to minimize the possibility of damage and soiling during the remainder of the construction period.

**1.8 DISTRIBUTED CONTROL OPERATION**

A. General

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The control system shall use "Programmable Logic Controllers" (PLCs) at all locations in the system as detailed later in these specifications. Each site in the system shall have a unique digital address. The Central Processing Units (CPUs) and Input/Output (I/O) cards used in each of the PLCs shall all be identical, fully interchangeable with out reprogramming by the operator. The PLCs shall be "self-initializing" and "self restoring" so that operator intervention is not required after power interruptions, transients from lightning storms, or component changes.

The system shall be composed of a Central Terminal Unit (CTU) that monitors and or controls the operation of multiple Remote Terminal Units (RTUs). The CTU shall be composed of a PLC (as described above) and one or more Operator Display Consoles (ODCs) with Human-Machine-Interface (HMI) software to display, alarm, record, all data received and for operator input for changes to the system.

The control system shall be capable of implementing multiple modes of communications in a single system to include: radio, leased phone-line, dial-up phone-line, high speed data highway, fiber optic, and Ethernet communications as details in these specifications. The individual sites in the system shall simultaneously support both Master-Slave and Peer-to-Peer communications as needed implement the distributed control features listed in these specifications.

### B. Distributed Control Software Features

The system shall be a "distributed control" type system that simultaneously provides for the features of both "supervisory control" (ie centralize control of RTUs from the CTU ) and "distributed control" (ie RTU self initiated control using local inputs and peer-to-peer communications with other RTUs) in to a single unified control system. The control system shall simultaneously support both Master-Slave (ie CTU to RTU) and Peer-to-Peer (i.e. RTU to RTU) communications to provide completely automatic control with no single point of system wide failure in either the PLC system or the communications system. The systems integrator shall implement redundant communications paths between RTUs to maintain automatic control in the event of CTU or system wide communications failure.

The control algorithms shall have the ability to integrate both hardware and software operator inputs (ie ODC setpoints and selector switch inputs) along with hardware inputs at the remote sites (ie remote Hand/Off/Auto selector switches, etc.) in to a unified cohesive automatic control system. As data is received, changes, or lost (i.e. a loss of signal from a RTU or CTU), the Central Unit control logic shall automatically adjust the controlling algorithm to the new situation.

In general the RTUs shall receive and store control parameter commands as inputted by the operator from both the CTU and the RTU. These inputs shall be displayed at both the CTU and RTU. Distributed control shall provide for fully automatic by the RTU based on the pre-programmed control algorithm, operator inputs received from the CTU, operator inputs received from the RTU front panel display, data received from other RTUs, and local inputs monitored at the RTU. For example, the RTU shall based on operator inputs automatically control the operation of pumps or valves based on level data received from other RTUs and local pressure, flow, and discrete inputs monitored at the RTU. Pump call/run/fail status shall be reported to the CTU for centralize display, alarming, and recording. The RTU distributed control algorithm shall handle the daily pump call/run/fail, automatic alternation, automatic transfer on fail, high discharge cut-off, low suction cut-off, low & high flow cut-off and basic tank fill or demand supply operations at the pump station for RTUs as detailed for each RTU.

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Supervisory control shall automatically or manually provide for the CTU to be able to override or modify the automatic operation of RTUs based on a pre-programmed control algorithm. For example, the CTU shall be able to automatically turn on or off pumps at RTUs or change RTU operational parameters as needed to satisfy "system" wide requirements such as peak load shedding for power or water distribution management during peak demand periods. The control system shall provide for multiple levels of control such that a single point of failure shall not render the control system in-operative:

1. In the event of a ODC failure, the PLC at the shall continue to poll all of the RTUs to collect data and provide supervisory control.
2. In the event of PLC failure at the CTU, the individual RTUs shall continue to provide fully automatic control using last stored operator inputs and peer-to-peer communications with other RTUs for control data as needed.
3. In the event of peer-to-peer communications failure between RTUs, the controlling RTUs (ie sites with pumps, valves, etc) shall continue to provide automatic control based on locally sensed pressures and flows.
4. In the event of complete failure of local RTU at a booster station (or similar site), the failure shall cause a "system normal" lamp and relay to be de-energized to automatically re-engage any existing back-up control system (such as pressure switches, float switches, etc.) to maintain automatic control.

The system shall automatically revert to the next higher level of control as communications or equipment failures are repaired.

### C. Standard Control Software Features

The supplied software shall not be a one-of-a-kind system, but rather a comprehensively designed software platform that provides a number of built in features that monitor local & remote inputs combined with standard software algorithms to provide an integrated system as follows:

1. Monitor local Hand/Off/Automatic (HOA) selector switch positions (ie on existing pump control panels) and integrate the switch position in to the control logic such that a HOA in HAND or OFF shall be considered by the control system as 'un-available'.
2. Provide for High Discharge Cut-off and Low Suction Cut-off control of pumps from locally entered setpoints at RTUs equipped with suction and discharge pressure transmitters and/or from existing pressure switches.
3. Provide automatic Pressure/Flow pump staging operation of pumps of different sizes (including variable speed pumps) from local discharge pressure and discharge flow inputs in a closed-loop system. The pumps shall be up-staged on decreasing discharge pressure and down-staged on decreasing flow rate. The control shall include PID (Proportional Integral Derivative) loop control of variable speed pumps mixed with constant speed pumps for the various stages required.
4. Provide "Compound Loop" PID control of final devices (ie chemical feeders) from multiple inputs (ie flow rate and a chemical process analyzer, such as chlorine residual).

## 1.9 RADIO CHANNEL DATA OPERATION

### A. General

The control system shall be specifically designed for radio channel data communications. The core of the system shall be over FCC licensed radio frequency spectrum intended for SCADA and remote control purposes. The systems integrator shall be responsible of obtaining the

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necessary FCC licenses for one or more frequencies as needed to establish both supervisory and distributed control.

All of the equipment required for operation of the system shall be directly owned by the Owner and included as part of this contract. Systems using third party repeaters, trunking masters, or leased equipment will not be allowed. The Systems Integrator shall select radio equipment as detailed below to insure reliable operation and be able to implement all software features listed in this specification whether currently required or described as a "shall be capable" feature.

The overall system design and operation shall provide a 20db pad over the minimum required for operation on all primary data paths (primary paths may include data relays) to insure a 98% reliability of communications. Remote site communications for distributed peer-to-peer communications shall provide 30db of pad to insure operation under all weather conditions and provide a 99.9% communications reliability. The 20db and 30db pad requirements and FCC rule compliance shall be demonstrated (at no additional cost) to the Engineer at his request. The testing shall be accomplished using an IFR AM/FM 1000S communications analyzer or equal equipment.

### B. Communications

The CTU-RTU supervisory communications and RTU-RTU distributed control communications system shall operate in a half-duplex mode over a single "licensed" radio frequency using "point-to-point" communication techniques. The RTUs shall monitor for the channel to avoid data collisions with other RTUs during peer-to-peer communications. The system shall be capable of sharing the radio channel with other radio telemetry system.

To facilitate system layout and future expansion all RTUs shall under the direction of the CTU be able to implement store-and-forward communications to relay data and commands to and from other RTUs as required to establish the desired path. Should the assigned relay site for a distant remote be inoperative, the Central Unit shall automatically choose another remote site to access the distant remote. Any RTU shall be able to provide automatic antenna switching as part of their relaying operations.

All data transmitted shall be in digital word form using FSK (frequency shift keying) transmission. All transmissions shall include the address of the sender and the receiver, and be subject to check sum, parity, and framing error checks, to insure a minimum data reliability of 1 error in 1,000,000,000 bits. Any transmissions that fail the data checking will be retried until correct. No data correction methods will be allowed. A plug-in RS232C data port shall be provided at all locations in the system to allow the use of a standard data terminal to view data exchanges between the sites and to provide a means of extensive de-bugging.

The system shall provide a complete data update at least once every (2) minutes with some functions updating faster as required by local system conditions.

### C. Radio Channel Operation

The system shall be capable of operation on the narrow band splinter frequencies of the Private Land Mobile Radio Services within the Federal Communications Commissions (FCC) rules and regulations regarding these telemetry channels. The manufacture shall guarantee operation under co-channel conditions with other radio systems without interference to this system. FSK tones, data baud rates, transmitter output power, transmitter deviation, antenna gain, and

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antenna height shall be chosen to comply with the FCC requirements Part 90 - Subpart 90.35 and 90.238 for the Industrial/Business frequency pools. The radio system shall specifically meet the operating requirement that the sum of the highest FSK frequency and the amount of deviation shall not exceed 1.7 kHz for 3F2 emission (or 2.8 kHz for 6F2 emission) as detailed by the FCC for the specific frequency assigned.

CTUs and RTUs shall be capable of automatically switching antennas and/or radios (including radios on different frequencies) during CTU-RTU, RTU-RTU, and store & forward communications. The antenna/radio switching at remote units shall automatically default back to RTU-CTU paths if communications are lost with the CTU.

D. FCC Licensing

The system manufacturer/supplier shall be responsible for collecting all information, generating all paper work, and paying all fees required obtaining a license on behalf of the Owner.

**PART 2 - PRODUCTS**

**2.1 PROGRAMMABLE LOGIC CONTROLLERS & LOCAL I/O EQUIPMENT**

A. General

Industrial Programmable Logic Controllers (PLCs) shall be used at all locations. The PLCs shall have an operational range of 0-60degC and 5-95% relative humidity. The PLCs shall all be from the same family of controllers, scalable from very small to very large applications, and programmed from identical programming software used for all processors. The PLCs shall be readily available on and directly purchasable online from the manufacture's WEB page. The PLCs shall be Allen-Bradley CompactLogix or Micro-Comm M1550 Series controllers.

**The software at all locations shall be stored in a user removable non-volatile CompactFlash or similar type ROM memory that can be exchanged under power, used to upgrade sites in the field, and store historical data (local trends, accumulators, etc) for retrieval locally or by the central unit. The memory modules shall store all site-specific logic and configurations including communication parameters, control algorithms, analog input/output scaling, PID control parameters. The module shall be programmed via the CPU and without the use of external adapters. The PLCs shall include "watch-dog" circuitry and be "self-initializing" without operator intervention. In the event that the program or configuration data is corrupted, the CPU shall reload the program and configuration data from the EEPROM memory module.**

The PLCs shall be fully online programmable while the PLC continues to communicate with the rest of the system and performs its assigned control tasks. The PLCs shall support "fill-in-the-blank" type configuration for basic operation and to set-up common features such as COM port set-up, peer-to-peer data collections, local back-up control set points, input and output setup, output on/off time delay settings, front panel display setup, etc. The PLC shall also support a process script language or ladder logic type programming for site-specific customizations including special input and output manipulations, local sequential control, math functions, and PID control as follows:

1. Relay (Bit) Type                      - Examine if ON, Examine if OFF

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- |                      |  |
|----------------------|--|
| 2. Timer & Counter   | - Timer ON, Timer OFF, Timer DONE                |
| 3. Compare Functions | - Equal, Not Equal, Greater Than, Less Than, etc |
| 4. Math Functions    | - Add, Subtract, Multiply, Divide, Square Root   |
| 5. Scaling Functions | - Scale & Scale with Parameters                  |
| 6. Logical Functions | - AND, OR, & NOT                                 |
| 7. Program Control   | - Jump & Skip Next functions                     |
| 8. PID               | - PID with compound loop input                   |

The PLC programming software shall be written for the 32 bit interface of Windows XP. The supplier shall provide a licensed copy of the PLC configuration and programming software along with the necessary communications cables to the owner. Training on the use of the software shall be provided as part of the system training.

B. Construction

The PLC shall use modular construction. The base unit shall be composed of the power supply, CPU, communications modules, and basic inputs and outputs (I/O). The unit shall have expandable inputs and outputs using a "rack-less" DIN rail mount design and capable of supporting local I/O (via an integrated high-performance serial I/O bus) and remote I/O via a industrial serial bus. All terminations shall use removable, NEMA-style "finger-safe" terminal blocks so that individual modules may be removed with out disturbing adjacent modules.

The PLC shall be capable of being powered from AC, DC, or solar sources. DC and solar powered PLCs shall have an integral battery charging circuit that protects the external battery from over and under voltage conditions and provides automatic charging of the battery after power failures. The back-up power supply shall be either 12VDC with 24VDC DC/DC converter or 24VDC with a 12VDC DC/DC converter to run the 12VDC radio and 24VDC to power external sensors from a single battery source. Series tapped 24VDC batteries for 12VDC will not be allowed. Back-up batteries shall be rechargeable sealed lead-acid type batteries as manufactured by PowerSonic or equal. The back-up battery shall provide for 24 hours of back-up operation at water tower remote units and 3 hours at all other sites.

The PLC shall have a minimum of two (2) communications ports. The first shall be used primarily for CTU-RTU and RTU-RTU communications. It shall support baud rates of 110-19,200 baud and have a plug-in standard 25pin or 9pin sub-D connector that provides a full RS232 interface and radio modem interface. The second communications port shall provide programming, operator front panel interface, multiple PLC interconnect and other local communications. It shall support baud rates of 110-19,200 baud and have a 9-pin sub-D interface. The communications ports shall include LED's to show the status of all control lines. The PLC shall also optionally support Ethernet communications as detailed in the specifications.

The PLC shall utilize a rack-less design and provide for sufficient installed and configured spare inputs and outputs (I/O) to meet the site requirements as detailed and provide for 25% spares of each type. The unit shall have a minimum of (4) discrete (relay) outputs, (8) discrete inputs (DI), (4) analog inputs (AI), and (2) analog outputs (AO). The analog inputs shall provide for sensor excitation with separate fuses for each input. The fuses may be the self-resetting type. All input and output connections to the PLC shall be via Nema "finger-safe" plug-in terminal blocks.



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The PLC shall support both local and remote I/O. Input/Output cards shall be mounted on a DIN rail channel. The PLC inputs, outputs, and operator interface shall be as follows:

1. DISCRETE OUTPUTS - The discrete outputs shall be isolated relay outputs rated at 5.0A continuous @ 240VAC. LEDs on the front of the PLC base unit or expansion module shall indicate the status of each output point. Interposing relays shall be provided if the voltage or current of the external load on a contact exceed the 5.0A 240VAC ratings. Each output shall be provided with operator settable software ON and OFF time delays.
2. DISCRETE INPUTS - The discrete inputs shall be optically isolated and provide for 24VDC excitation to remote sensors and switches. Each input shall be separately fused or current limited such that accidental grounding shall not render the other inputs non-functional. LEDs on the front of the input module shall indicate the status of each input point.
3. ANALOG INPUTS - The analog inputs shall provide filtered and scalable analog to digital conversion of input signals. The analog inputs shall be switch selectable from 0-5VDC to 0-20mADC and provide a minimum of 0.3% resolution and 0.5% accuracy over the temperature range of 0-70degrees C. The PLC shall provide separately fused 24VDC excitations to the remote sensors.
4. ANALOG OUTPUTS - The analog outputs shall provide a 4-20mA isolated signal to other panels and devices as specified.
5. PULSE INPUTS - The high-speed counter/pulse inputs shall provide for pulse rates up to 1KHz direct from flow meter transmitter heads without interposing equipment. The pulse input shall include fused 12VDC excitation to the meter transmitter.
6. POWER SUPPLY - Each PLC assembly shall include an integral power supply. Power supplies shall be designed for 12VDC or 24VDC input power and suitable for use in battery back-up operations. DC/DC converters shall be required to insure that both the 12VDC and 24VDC are regulated separately from the common source.
7. KEYPAD & DISPLAY UNIT - The optional keypad & display unit shall have a 4x20 back-lighted LCD display to display the status of all local inputs and the tank level of the associated control water tower level. The 5x5 keypad shall provide for operator input of set points and timer settings. The operator interface shall be menu driven and provide for dedicated keys for cursor position and input functions. The operator interface shall provide for up to 50 screens of data display. The keypad & display unit shall be supplied and mounted on the front of the PLC enclosure if detailed in the specific PLC I/O requirement list. The keypad & display unit shall maintain the Nema 4 rating of the PLC enclosure.

C. Enclosures

The remote unit enclosures for indoor mounting shall meet all the requirements for NEMA Type 12 enclosures. The enclosures body shall be made of a minimum 14 gauge steel with continuously welded seams and be furnished with external mounting feet. The enclosure door shall be made of a minimum 16 gauge steel with have a 14 gauge steel hinge. Enclosures larger than 16x14 shall have a rolled lip on 3 sides of the door for added strength. The door opening shall have a rolled edge on 4 sides to protect the door gasket. The door gasket shall be heavy neoprene and attached to the door with oil resistant adhesive. Sub-panels shall be 14-gauge steel for 16x14 enclosures and 12 gauge for larger enclosures. The enclosure finish shall be gray polyester powder coating inside and out over phosphatized surfaces. The subpanels shall be finished in white. Nema 12 enclosures shall be Hoffman "CH" or "CONCEPT" wall mount enclosures.

Remote site installations requiring equipment to be mounted outside shall have a double box enclosure with the remote unit enclosure mounted inside a lockable NEMA 3R enclosure. The

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double enclosure shall be required to control vandalism, provide complete weather protection, reduce the heating effects of the sun, and prolong the life of the equipment. The NEMA 3R enclosure shall be constructed of 14 gauge galvanized steel, with a drip shield top and seems free sides front and back, and a stainless steel hinge pin. The enclosure finish shall be gray polyester powder coating inside and out over phosphatized surfaces. The NEMA 3R enclosure shall be Hoffman Bulletin A-3.

The remote unit enclosures mounted in damp corrosive areas (such as concrete meter vaults) shall be NEMA Type 4X rated enclosures. The enclosures shall be made of molded fiberglass polyester and be furnished with external mounting feet. The door shall have a seamless foam-in-place gasket and corrosion-resistant hinge pin and bails. Sub-panels shall be 14-gauge steel for 16x14 enclosures and 12 gauge for larger enclosures. The enclosure finish shall be a light gray inside and out. The subpanels shall be finished in white. Nema type 4X enclosures shall be Hoffman "Fiberglass Hinged Cover".

*Refer to Appendix for specific enclosure requirements.*

### D. Local Control Functions

In general the PLC shall be programmed to provide generic control functions as detailed earlier and to work in concert with the CTU. The integrator shall be responsible to meet with the owner and the engineer to develop the automatic control strategy required for the system.

*Refer to Appendix for special input and output control requirements.*

## 2.2 RADIO TRANSCEIVERS & ACCESSORIES

### A. General

The radio transceivers shall be standard "un-modified" radios that can be tuned, aligned, and repaired at any two-way radio shop. Interface to external data modems shall be through the front panel microphone jack. The radios shall be synthesized and fully field programmable and include a built-in time-out timer to disable the transmitter after 0-60seconds. The units shall be tuned to FCC specifications for the specific frequency assigned. The radio equipment shall be FCC type approved and the system capable of operation on the 3KHz or 6KHz narrow band splinter frequencies (154 or 173MHz) in the Industrial/Business radio service.

### B. VHF Radio Transceiver (154Mhz or 173Mhz)

The system manufacturer shall supply a 5-watt VHF radio transceiver to insure a high level of quality and reliability. The radios shall be adjustable to 4 watts output power as may be required by the FCC for ERP (Effective Radiated Power) restrictions. All connections to the radio shall be plug-in. The VHF radio transceiver shall have the following specifications:

#### Transmitter:

RF output power	25 watts minimum (adjustable to 4)
Spurs & Harmonics	16 dBm (25uW) (or -50dBc)
Frequency stability	±0.00025% (-30 to +60 degrees C)
Emission	6F2 (2.5kHz DEV max) or 3F2 (1.2kHz DEV max)
FM hum and noise	-40 dB

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Receiver:

Sensitivity	0.35uV @ 12 dB SINAD (.5uV @ 20db quieting)
Selectivity	-65 dB
Spurious image rejection	-50 dB
Inter-modulation	-65 dB
Frequency stability	$\pm 0.00025\%$ (-30 to +60 degrees C)
Receive bandwidth	*6kHz (or 3kHz) as required to match the transmitter

\* The receiver bandwidth shall be reduced to match the transmit bandwidth of the transmitter and provide a minimum adjacent channel rejection of -50db.

The radio transceivers shall be a Motorola Radius CM200 or a Microwave Data Systems 1710.

C. UHF Radio Transceiver (450Mhz)

If the system supplier can demonstrate to the satisfaction of the Engineer that no VHF (154-173 MHz) frequency can be obtained, an UHF (450-470 MHz) frequency may be used. The UHF shall operate under Part 90.35 and 90.238 for secondary fixed operations. The system will still be required to operate with point-to-point operation within the FCC rules and regulations and provide the same RF path margins as detailed in these specifications.

The UHF radios must meet or exceed the requirements set forth in these specifications for VHF radios, except that the radio output power must be adjustable to 2 watts as needed to meet FCC requirements. The radios shall be tuned to operate in 6KHz of bandwidth to meet the proposed FCC standards for 2005. Antennas shall provide a minimum 10db of gain.

The radio transceivers shall be Motorola Radius CM200 or Microwave Data Systems 4710. No changes to the contract amount will be made for a change to UHF operation.

D. Antenna & coaxial cable

The radio antennas at all locations shall be a five element Yagi, constructed with 3/8" diameter solid aluminum rod elements and 1-1/16" diameter aluminum pipe element support with a type N coaxial connector. The antenna shall have a minimum 8.0db forward gain with a 20.0db front-to-back ratio. The antenna shall be wind rated for a 100-MPH wind speed. The VHF antennas shall be MC-Yagi, Decibel Products DB292, or Celwave PD390S. The UHF antennas shall be MC-Yagi or Celwave PD688S.

Antennas shall be cabled to the transmitter enclosure connection by a RG/8U type low loss (less than 1.8db per 100ft @ 100MHz) coaxial cable with cellular polyethylene (foam) dielectric. The coaxial cable shall have braided copper shield coverage of 97% and a long life weather resistant polyvinyl chloride jacket. The antenna coaxial cable connection shall be a constant impedance weatherproof Type N connector, taped with a weather resistant electrical tape to insure a lifetime watertight assembly. The coaxial cable shall be Belden 8214 or 9913 cables.

E. Antenna Lightning Protection

Coaxial connection to remote and central unit enclosures shall be by means of a coaxial type bulkhead lightning arrestor. The units shall be rated at 1 kilowatt with a minimum 500V and maximum 2000V-breakdown voltage. Coaxial lightning arrestors shall be a PD-593 or PolyPhaser IS-B50LN-C1.

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### F. Antenna Mounting Systems

Antennas shall be mounted at a height above ground that is consistent with FCC rules and regulations and provides adequate signal fade margin as described earlier. Antennas must be a minimum of 15 feet above ground and mounted as follows:

1. Water Towers: The antenna shall be mounted on the ladder or the water tower catwalk railing at a height consistent with FCC requirements. The coaxial cable shall be secured to the ladder or obstruction lighting conduit. A 3/4" rigid conduit with a weather-head shall be provided from the transmitter to the ladder on the tower.
2. Above Ground Structures: The antenna shall be mounted on a 10' long X 1-1/2" diameter galvanized mast with top mounted weather-head. The mast assembly shall be secured to the side of the structure with Uni-strut clamps. The coaxial cable shall feed through the mast assembly to the interior of the building.
3. Below Ground Structures: The antenna shall be mounted on a 20' high Class II power pole with a 10' long X 1-1/2" galvanized mast secured to the side of the pole and extending 5' above the pole or a 20' high free-standing antenna tower. A 3/4" rigid conduit with a weather-head shall be provided from the below ground vault to a location 10 feet up the power pole for the coaxial cable.
4. Antenna Towers (>20feet): A bracketed antenna tower shall be supplied where specifically noted on the plans or in the RTU & CTU site descriptions. The tower shall be assembled from 10 sections built on a 12-1/2" (or 18" for ROHN 45G) equilateral triangle design. Tower sections shall be constructed of 1-1/4" steel tubing with continuous solid steel rod "zigzag" cross bracing electrically welded to the tubing. The entire 10' sections shall be Hot-Dip Galvanized after fabrication for long life. The antenna towers shall be ROHN Model 25G (for unsupported heights of up to 33 feet) or ROHN Model 45G (for unsupported heights less than 45 feet).

## 2.3 INSTRUMENTATION & ACCESSORIES

### A. General

All items in the control system (electronic cards, power supplies, radios, time delays, relays, etc.) shall be of plug-in construction, make use of a plug-in wiring harness, use plug-in terminal blocks, and be interchangeable without recalibration. To insure field repair-ability by non-technical personnel, equipment that must be un-wired for replacement will not be accepted.

The following instrumentation devices and techniques shall be used as specifically called for in the RTU and CTU input/output sections of this specification.

### B. Power Supplies

The DC power supplies shall provide  $\pm 0.1\%$  line and load regulation with  $\pm 10\%$  input variations. They shall have a temperature coefficient of  $\pm 0.02\%$  per degree C. The input/output isolation shall be 100 Mohms DC (900Volts AC) with output transient response of 50 microseconds maximum. The power supplies shall be sized to operate the remote unit equipment with or without the back-up battery in place. Power Supplies shall be a Power One Series MAP130, Sola SLS, or approved equal.

### C. Battery Back-up Operation

The remote units indicated shall be supplied with battery back-up operation. The rechargeable batteries shall be the sealed solid gelled electrolyte types, designed for float or standby service. Unless noted otherwise in the RTU descriptions, batteries shall be sized to maintain 24-hour

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service at water tower remotes and 8-hour service at pump stations and other remotes. The remote shall include a charging module to recharge the battery when power is resumed, maintain the charge between outages, and provide a low voltage cut-off to protect the battery from excessive discharge during prolonged outages. All discrete, analog, and pulse inputs (i.e. switch closures, pressure, level, flows, etc.) shall continue to function on battery back up. Batteries shall be Globe Gel/Cell or approved equal.

### D. Single Phase 120VAC Power Line Lightning Protection

Every site in the system shall be equipped with AC line filtering and lightning protection. The equipment shall provide 2-stage lightning/transient protection including inductive and capacitive filtering and MOV over-voltage protection.

### E. Level & Pressure Transducers

Level & pressure transducers shall be of the all solid-state two-wire transmitter type with a 4-20mA output from a 10.5-24VDC excitation. The units shall be powered from the RTU power supply. The transducers shall have a combined error (linearity and hysteresis) of  $\pm 0.25\%$  full scale and be temperature compensated to  $\pm 2.5\%$  per 100 degrees Fahrenheit. Zero and span adjustments shall be standardized so that transducers are interchangeable without recalibration. All exposed or wetted parts shall be series 316 stainless steel, PVC, or Buna-N. The units shall be capable of a three times full scale over pressure with out damage or change of calibration.

The transducers shall be mounted at the sensing point and wired to the enclosure. The transducers shall have a 1/4" or 1/2" NPT process pressure connection. Transducers for above ground mounting shall have a 1/2" conduit connection for cable entry. Transducers at water towers (and other outside locations) shall be mounted below grade and below frost line to prevent freezing. Below grade mounted units shall have factory signal cabling and be suitable for a minimum of 100' submerged duty.

Level transducers for clear-wells and wetwells shall be suspended in the clearwell or wetwell and supplied with sufficient factory installed cable to access a "clean/dry area" junction box. The suspension cable shall have a polyethylene jacket and internal venting to provide for atmospheric sensing of the non-process side of the diaphragm. The sensors shall have a multi-ported pressure-sensing end that protects the diaphragm while sensing the level of viscous liquids or slurries. The cable connection in wet-well applications shall have a non-fouling guard to prevent build up of foreign materials.

Pressure/Level transducers shall be Micro-Comm L5N series, Consolidated A300 Model 221GEE, or Ametek Model 57S.

## 2.4 CENTRAL UNIT EQUIPMENT

### A. General

The "Central Unit" shall be composed of two or more separate CPUs communicating over a high-speed serial data links. The first computer (called the Central Terminal Unit or CTU) shall be a PLC as specified earlier and provide all communications with remote units, local inputs and outputs, and local hardware display devices. The second computer (called the Operator Display Console or ODC) shall be responsible for the operator interface to the system and provide display, alarm, and logging of all data.

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B. Construction

The CTU shall be as specified for the PLCs used on the project. The CTU control panel shall be equipped with a battery back up. The CTU shall operate for a minimum of 8 hours controlling all radio/RTU operations. The rechargeable 12 amp hour batteries shall be sealed solid gelled electrolyte type batteries. The CTU shall recharge, maintain, and contain a low voltage cut-off protecting the battery from excessive discharge.

C. Enclosures

All of the CTU and PLC equipment (including CPU card cage, radio, power supplies, automatic antenna switching, and local inputs & outputs) at the master shall be housed in a free standing or wall mount NEMA 12 enclosure.

*Refer to Appendix for specific enclosure requirements.*

D. Local Control Functions

In general the CTU shall be programmed to provide generic control functions as detailed earlier. The integrator shall be responsible to meet with the owner and the engineer to develop the automatic control strategy required for the system.

*Refer to Appendix for special input and output control requirements.*

## 2.5 OPERATOR DISPLAY CONSOLE (ODC)

A. General

As described previously the Central Unit shall have two microprocessors tied together with separate operating responsibilities. The first processor (Central Terminal Unit or CTU-PLC) shall handle all the telemetry, set-point comparison and command duties. The second processor (Operator Display Console or ODC) shall handle the LCD displays, operator keyboard, alarm/log printer, and data storage duties. The system shall be capable of supporting multiple ODCs connected to a single CTU-PLC.

B. System Unit (Front Panel Industrial Computer)

The Operator Display Console (ODC) computer shall be an Intel/Windows base processor with the following features:

1. Celeron M Processor operating at 1GHz (minimum)
2. Windows XP Professional operating system
3. 2GB RAM (minimum)
4. 16GB SATA Hard Drive (minimum)
5. Integral Gigabit wired Network Adapter
6. 56K V.92 Data/Fax modem
7. (4) USB 2.0 ports (used for Thumb-drive data transfer)

The system unit shall be housed in din rail mountable enclosure. The CTU shall store all command inputs and set points as downloaded from the ODC. The hard drive in the ODC shall be used for program and data storage. The Fixed Hard drive and Thumb-drive shall be used for archive data storage and back-up protection of the operating program.

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The ODC-System Unit shall be a minimum Rockwell/Allen Bradley Model 200R (6155F) Solid State drive or latest current model.

### C. Touch Screen Display

The Touch Screen Display shall be an Industrial rated color active matrix TFT flat panel display. The TFT display shall be a 15" high-resolution (1024 x 768) color display terminal with 16.7 million colors. The TFT display shall be utilized for display of station and system graphics and real-time data display. The TFT display shall provide for operator input and output data, multiple graphic overviews, report generation, and access to system utilities. The TFT display shall be a minimum Rockwell/Allen Bradley Model 6176-1550M Flat Panel Monitor or latest available model.

### D. Printer

The system shall be capable of interfacing via USB to an owner supplied Inkjet printer.

### E. Internal Modem

The internal modem shall be reserved for phone-line debug & remote access.

The ODC shall include Symantec's current version of PCAnywhere for remote access by the Owner's or Systems Integrator's remote computers.

### F. Battery Back-up Operation

The ODC shall include 20 minutes of back up. The ODC back-up unit shall be a Stand-by Uninterruptible Power Supply (UPS) system that provides power line filtering and transient protection. The unit shall automatically take over (within 4mS) when the power line fails without interrupting or restarting the system and automatically recharge the battery within 10hours after the power returns to normal. The UPS shall be located at the desk location of the ODC and shall power the System Unit and display. The UPS shall be an APC Back-UPS 650, 1000, or 1400 as required.

## 2.6 MAIN OPERATOR DISPLAY CONSOLE SOFTWARE

### A. General

The software shall be 32bit compatible and capable of operating in the ODC hardware described above as well as in customer supplied Windows XP Professional compatible hardware similar to the unit specified above. The contractor shall supply a fully functional "developmental" version of the SCADA software (including any required software protection keys) for the first ODC as well as a separate configured "runtime" version for installation and use in a customer supplied back-up computer. The software may be modular, however the operator interface shall provide an integrated interface to all areas of the program. Demo program copies will not be allowed.

The software shall operate in the 64-bit Windows XP or Windows 7 Professional Business environment. The software shall be the latest "full developmental" version of SCADAVIEW CSX (Client/Server), Wonderware InTouch, GE-Fanuc iFIX, or Allen-Bradley RSView 32 (Optional SE). The software shall be licensed to the owner.

### B. System Back-up & Installation

The contractor shall provide a back-up copy of the installed software on an USB-Thumb drive. Back-up copies of any setup or graphic files shall be on an USB-Thumb drive. In the event of a

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catastrophic failure, the Owner shall utilize the USB-Thumb drive for emergency reloading the software. The contractor shall provide an easy to use installation (or re-installation) program that will automatically setup the hard drive operating system and automatically load (or reload) the software.

C. System Capacity

At a minimum, the operating software shall be capable of accommodating 32,000 tag points as follows:

1. Discrete status & alarm points
2. Measured variables
3. Accumulated variables
4. Calculated status & alarm points
5. Calculated control points

D. Communications

The HMI shall have several methods for exchanging data from programmable controllers and other software programs.

1. Direct
2. DDE Client/Server
3. OPC Client
4. ODBC
5. SQL Database (MySQL, MS-SQL, PostgreSQL)

E. HMI Operational Characteristics:

In general, the HMI software shall display all received data in engineering units with appropriate generated labels, generate and print alarms, print logs, store manually entered data, update displays, and perform operator commands as required by the database. The system shall automatically generate the following system displays:

1. Main Menu page (with direct access to all screens and other program modules)
2. System Summary page listing key data points for all RTUs in the system
3. RTU specific display pages showing all data for each RTU in the system

Beyond the basic operating software required for SCADA operations, the software package shall accommodate the following:

1. Status Point Operations:
  - a. Display ODC, CTU, and RTU status functions
  - b. Input/Display control database
2. Analog Data:
  - a. Display value directly in engineering units
  - b. Accept operator High & Low alarm limits and generate alarms
  - c. Accept operator rate of change alarm limit and generate alarm
  - d. Store data for trending displays
3. Flow Rate Data:
  - a. Display value directly in engineering units
  - b. Accept operator High & Low rate alarm limits and generate alarms
  - c. Totalize flow total and display in engineering units
  - d. Accept operator High/Low 24 hour total limits and alarms
  - e. Store data for trending displays
4. Pump Control Operations:
  - a. Display ODC, CTU, and RTU HAND/OFF/AUTO functions



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- b. Display Pump CALL/RUN/FAIL status for each pump
  - c. Input/Display control database
  - 5. Alarm Point Operations:
    - a. Display ODC, CTU, and RTU alarm functions
    - b. Enter new alarm in data log archive and send alarm to printer
    - c. Sound alarm horn until alarm is acknowledge by the operator
    - d. Log alarm acknowledgment to data log and printer
    - e. Log alarm clearing and send alarm clear to printer
    - f. Input/Display control database
  - 6. Event Point Operations:
    - a. Display ODC, CTU, and RTU alarm functions
    - b. Display ODC, CTU, and RTU event functions
    - c. Enter new event in data log archive and send alarm to printer
    - d. Log event clearing and send alarm clear to printer
    - e. Input/Display control database
  - 7. Historical Trending Operations:
    - a. Real-time and historical trending functions
    - b. Create a multi-pen trend.
    - c. Ability to be shaded to compare two or more different trends
    - d. Create a trend that is part of a graphic display
    - e. The trends shall have a marker displaying the pen's date, time, and value
- F. Graphical Screen Display Editor
- The HMI shall provide a graphics display editor for creating displays using graphic objects. The graphics display editor shall have the ability to drag and drop objects from a pre-configured graphics library, paste objects that are copied to the clipboard from another Windows application, and insert objects created by another Windows application using OLE. True OLE support is required in that it shall be possible to call up the native application that created the object being inserted and use the naïve object editing tools from within the HMI. The graphics display editor shall have tear-away toolbars and color palettes. It shall be possible to customize the color pallet. Graphics drawn with a customized color pallet shall not require the customized color pallet to be present on all runtime computers. Colors must be stored internal to the graphic files as Red, Green, Blue numbers, not pallet indexes. The graphics display editor shall have:
- 1. Context sensitive "right-mouse" support on all objects.
  - 2. As a minimum the following drawing tools:  
Rectangle, line, ellipse, wedge, and text
  - 3. As a minimum the following editing tools:  
Tag substitute, flip, rotate, resize, reshape, align, cut, paste, copy, duplicate, bring to front, send to back, space, fill, undo, redo, line, and color.
  - 4. As a minimum the following viewing tools:  
Zoom in, zoom out, pan, and view entire graphic.
  - 5. The ability to use tag placeholders to provide a way to use one graphic display to represent a number of similar operations.
  - 6. Provide tools for each of the following as a minimum:  
Numeric input, numeric display, string input, string display, label, arrow, recipe, alarm summary, tag monitor, input command line, trend, button, OLE object, and ActiveX object.
  - 7. The ability to create a screen background by converting objects to wallpaper. These wallpaper objects cannot be selected or edited.

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8. Allow the user to create libraries of graphic objects.
9. Allow the user to assign control to any object or grouping of objects. It shall also allow the user to drill down in a group to modify any object or object attribute without losing any object control property.
10. Allow control to be copied from any object to another object.
11. Permit the user to specify screen placement anywhere on the display.

## **2.7 VOICE ALARM PHONE-DIALER**

### **A. General**

The ODC shall be equipped with software based automatic alarm dialer software. The software shall be tied to the MMI software database to provide automatic dialing of operator selected alarms. The software shall be 32bit compatible and capable of operating in the ODC hardware described above. The contractor shall supply a fully functional "developmental" version of the Alarm Dialer Software (including any required software protection keys) for the first ODC as well as a separate configured "runtime" version for installation and use in a customer supplied back-up computer. The software may be modular, however the operator interface shall provide an integrated interface to all areas of the program.

The software shall dial a pre-programmed list of phone numbers to provide a natural voice describing generated the specific alarm and time of occurrence. The dialer software shall have provisions to accept an operator acknowledgement of the alarm that will cancel further calls. If a proper acknowledgement is not received, the software will continue to dial phone numbers from the list until an acknowledgement is received.

The alarm dialer software shall allow operators to dial into the system to retrieve current alarm status and via a voice driven menu system access current operational data for each remote station.

### **B. Phone Dialer Modem**

The phone dialer software shall include a voice modem that will allow the ODC computer to interface with standard dial-up phone-lines. The modem shall be FCC type approved. The Alarm Dialer Software shall be SCADAdial, Win911, or SCADAAlarm.

## **PART 3 - EXECUTION**

### **3.1 EQUIPMENT EXAMINATION**

The control system shall be completely tested prior to shipment. The entire control system shall be "Burned In" at the factory for a period of at least 20 days. The component equipment shall be computer tested and temperature cycled at zero degrees and at fifty degrees centigrade.

### **3.2 SYSTEM START-UP**

The manufacturer shall supply "Factory" personnel for start-up service as needed to insure satisfactory operation. Subsequent trips to the job site to correct defects shall be made at no charge to the Owner during the warranty period.

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**3.3 TRAINING**

The system manufacturer shall supply "factory" personnel to conduct two separate on-site training sessions, totaling a minimum of three days of training.

The initial training session shall be conducted during start-up as needed until the Owner and Engineer are satisfied that the operators are comfortable with the operation and maintenance of the system. Training shall be done on site with the owner's personnel.

Three to six months after the Owner commencing system operation, the system manufacturer shall supply "factory" personnel to conduct follow-up training of the Owner's personnel. The follow-up training shall be conducted on-site and consist of reviewing the operation and maintenance of the system. The Owner shall be contacted a minimum of two weeks in advance, prior to scheduling the training session to allow proper coordination.

**3.4 SUBSTANTIAL COMPLETION**

The Engineer will grant substantial completion only after completion of the start-up and initial training phase of the project. The Engineer shall make an inspection of the system to determine the status of completion. Substantial completion will be awarded only when the system is providing usable service to the Owner. If the system is commissioned in phases, the Contractor may request substantial completion for the completed phases.

**3.5 WARRANTY/SUPPORT PROGRAM**

The control system manufacturer shall supply a TWO (2) year parts and labor warranty and comprehensive support program for all items and software supplied under this section (except as noted below). Power surges and lightning damage shall be included as part of the warranty.

The warranty shall begin from the time of "substantial completion" as issued by the engineer. The manufacturer shall provide a 24-hour response to calls from the Owner. The manufacturer, at his discretion, may dispatch replacement parts to the Owner by next-day delivery service for field replacement by the Owner. Any damage to the control system caused by the actions of the Owner in attempting these field replacements shall be the sole responsibility of the manufacturer. If, during the warranty period, satisfactory field repair cannot be attained by field replacement of parts by the Owner, the manufacturer shall dispatch "factory" personnel to the job site to complete repairs at no cost to the Owner.

The support program shall begin from the time of "substantial completion" as issued by the engineer. The support program shall include free updating of all software as needed and providing free phone support from the integrator throughout the warranty period.

The ODC Computer System Unit, Touch Screen Display, and associated UPS shall be covered by a one (1) year warranty beginning with "substantial completion". Lightning damage shall be included as part of the warranty on these components.

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**PART 4 - APPENDIX: DETAILED EQUIPMENT DESCRIPTION**

**4.1 WATER TOWER REMOTE UNIT REQUIREMENTS:**

A. Installation Requirements:

The tower transceiver NEMA 12 enclosure shall be mounted inside a vented, lockable, NEMA 3R enclosure as specified. The installation shall be detailed in the submittal process.

The level transducer shall be a two-wire transmitter suitable for below ground mounting as specified earlier. The level transducer shall be installed at a point below freezing in the altitude vault or in a 24" fiber meter vault with a freeze proof lid. The pressure connection shall be equipped with a corporation stop providing a 1/4" NPT female connection for the transducer. The contractor shall run 3/4" rigid conduit from the vault or meter box to the transceiver enclosure for the transducer signal cable.

The antenna shall be as specified and mounted on the water tower or on a 20' power pole with 3/4" rigid conduit and a weather-head run to the RTU enclosure as previously specified.

B. Front Panel Display Requirements:

1. Keypad LCD Display (Local Display of the Water Level)

C. Discrete Outputs:

1. spare
2. spare
3. spare
4. spare

D. Discrete Inputs:

1. Power Failure
2. spare
3. spare
4. spare
5. spare
6. spare
7. spare
8. spare

E. Analog Inputs:

1. Water Tower Level (data from new pressure transducer)
2. spare
3. spare
4. spare

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**4.2 VISITORS CENTER REMOTE UNIT REQUIREMENTS:**

A. Installation Requirements:

The RTU shall be mounted in a NEMA 12 enclosure as specified. The installation shall be detailed in the submittal process.

The antenna shall be mounted on a 10' long X 1-1/2" diameter mast secured to the side of the building with a weather-head/conduit run to the RTU enclosure.

B. Front Panel Display Requirements:

1. Keypad LCD Display (Display of the Storage Tank Water Level and Power Fail Alarms)

C. Discrete Outputs:

1. spare
2. spare
3. spare
4. spare

D. Discrete Inputs:

1. Power Failure
2. spare
3. spare
4. spare
5. spare
6. spare
7. spare
8. spare

E. Analog Inputs:

1. spare
2. spare
3. spare
4. spare

**4.3 PUMP HOUSE CTU REQUIREMENTS:**

A. Installation Requirements:

Telemetry Control and Pump Command outputs to other panels shall be dry isolated contacts on relays. Local pressure inputs shall be by two-wire transducers as specified.

The Pump Station equipment shall be housed in a NEMA 12 wall mount enclosure for indoor locations. The pump station equipment shall include an internal power switch, bulkhead coaxial cable lightning arrestor, and a power line lightning arrestor as specified earlier.

The CTU shall communicate with the remote PLC/RTUs via VHF/UHF radio frequency data network. The CTU shall include an Industrial Front Panel Touch-Screen PC-ODC Computer System specified earlier in this specification. The Industrial Front Panel computer shall include a Full Development Version of the HMI software specified earlier in this specification. The

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HMI software will be the primary control/monitoring/alarm station for the SCADA system. This software will include all standard day-to-day operation duties and alarm dialer duties.

The CTU antenna(s) shall be mounted on a 10' long X 1-1/2" diameter mast secured to the side of the building and a weather-head run to the CTU-PLC enclosure. The antennas should be mounted as close as possible to the CTU-PLC enclosure.

A red alarm light shall be mounted on the exterior of the new pump house building. The alarm light shall be connected to the central telemetry unit and shall be activated when any of the alarm conditions exist.

A green light shall be mounted on the exterior of the new pump house and connected to the central telemetry unit such that the light is activated whenever the pumps are in operation.

B. ODC-Touch Screen Front Panel Display Requirements:

1. Graphical HMI Software including monitoring and control of Historical Data Trending, Reporting, and Event/Alarm logging

C. Discrete Outputs:

1. Cistern Pump #1 CALL
2. Cistern Pump #2 CALL
3. Booster Pump #1 CALL
4. Booster Pump #2 CALL

Expansion Output Card

5. Chemical Feeder CALL
6. -16. Spares

D. Discrete Inputs:

1. Power Failure
2. Cistern Pump #1 RUNNING
3. Cistern Pump #2 RUNNING
4. Booster Pump #1 RUNNING
5. Booster Pump #2 RUNNING
6. Low UV Transmittance – System Alarm
7. RESERVED for future Chemical CL2 Low Alarm
8. RESERVED for future Turbidity High Alarm

E. Analog Inputs:

1. Lower Cistern Water Level Indication (New Transducer as specified earlier)
2. Discharge Pressure Indication (New Transducer as specified earlier)
3. RESERVED for future Chemical CL2 Residual Level
4. RESERVED for future Turbidity Level

F. Pulse Inputs:

1. FUTURE Flow Rate & Total (Reserved for future flow meter interface)
2. spare

